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THE LEICA MANUAL

A Manual for the Amateur and Professional Covering the Entire Field of Leica Photography.

by

WILLARD D. MORGAN

HENRY M. LESTER

and Contributors

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Barbara Morgan
for planning typographical and montage arrangement

Ruth Lester
for collaboration in the editing of the volume.

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BEFORE WE PRESS THE BUTTON

MANUEL KOMROFF

The world is large and filled with many things. It is difficult to get acquainted with so much. Existence seems to be crowded. It is hard to feel at home in a place so full—so crowded with joys and sorrows, dreams and hopes, as well as the multitude of objects that pour like an avalanche into our lives. The products of the machine age alone form a Niagara that seems overpowering. There is little time for leisure, and work seems the currency of our present-day life. But in spite of all this, nature continues to grow and unfold its loveliness.

Beauty is fearless and stands proudly beside the blast furnace or the dynamo. These monsters do not disturb her. She holds mysteries greater than anything done by the work of man. She was here long before the machine intruded upon our world, and she will remain long after the last cogwheel stops its grinding whirl. These two powerful forces stand side by side. Man must bow in reverence before it all. It is wonderful to be able to see and know a few things that are around us. And it is not possible to know more than a very few.

This idea has often impressed me. It is a little thing, but it is something I would like to record. I would like to show my friend a symbol of these two forces that exist side by side in the crowded world we live in. Somewhere I will find a little white flower growing beside a black factory chimney. It will be worth recording and I will touch a button and the hard cold and uncanny eye of the modern camera will embrace the idea. I will take home a record of what has been in my mind. I will want to show it to my friend so that he can see at a glance what I am thinking about.

I am thinking about the whole big world and our little lives. About great dynamos whose force man can control and a little white flower, growing beside them, which soon must wither and die, a force that man is unable to control. I am thinking of animals and vegetables and minerals and how all things fall into these three kingdoms to form the face of society. And I am thinking that all these things exist only as a kind of reflection . . . and we see them only as something that is projected on the mirror of the mind. This mirror is a very mysterious and a very important thing. It controls imagination and it has in it something that enriches our lives.

My friend sends me a snapshot of a white horse frisking across a field against a dark stormy sky. Before he pressed the button he used the mirror of his mind. It is a fine picture indeed, and I compare it with the old dray horse that I once photographed in the streets of New York. My picture shows a poor beast—heavy, worn, sleepy but very patient and most reliable. The pictures are different. But then our pictures are always different. Our minds are different, our eyes are different; our lives, experiences, and emotions have all been so very different. And even if we both photographed the same flowers or the same machine, our photographs would be quite different.

Both my friend and I know something about the technical side of photography. We both understand that the machine we are using is very flexible and most adaptable. We know a few of its limitations and some of its possibilities. We have chosen this very special type of machine that we use because of its extreme flexibility and because we believe that a machine can become an instrument of expression. A fair amount of knowledge and a sympathetic feeling can convert a mechanism into an instrument for expression. An artist would use a brush, but here we have chosen a machine to express something that is reflected on the mirror of our mind.

I am anxious to show you some of these reflections, to show you what I see in an animal, in a plant, or in a metal structure. I realize the power of visual perception, and I know that I can tell you a good deal with a small photograph, for I do not trust words too much. And I am also anxious to see what you have to show me. I am eager to learn about the world that you live in and compare it with the world that I know. They are the same, and yet they are strangely different.

A friend has just sent me a little picture that he has snapped of a murderer in Russia being led to prison. He is an ugly fellow, and brutality is written over his face. There is something creepy and loathsome about him. But he is not unlike a murderer in Australia, or France, or America. I see now by that little picture what a slight difference there is between them. And another friend has just sent me a photograph of lotus flowers floating in a garden pool in China. It is indeed very beautiful. But some of our own flowers are also beautiful. They also sprout and unfold, and in time they wither and die.

How alike things are in different parts of a large world. Brutality and ugliness exist in all places. And beauty is there also. But still there seems a little difference, and it is this difference which is quite fascinating. A Russian murderer and a murderer from Texas are both vile creatures, and we look at their pictures side by side and we compare the likes and the dislikes. And some of the flowers that grow in China are very different from our own, and we want to see more and more. There is interest in ugliness and there is pleasure in what is beautiful. So full is the world. And many things are so alike and yet so different.

Water Lily Yasuo Kuniyoshi

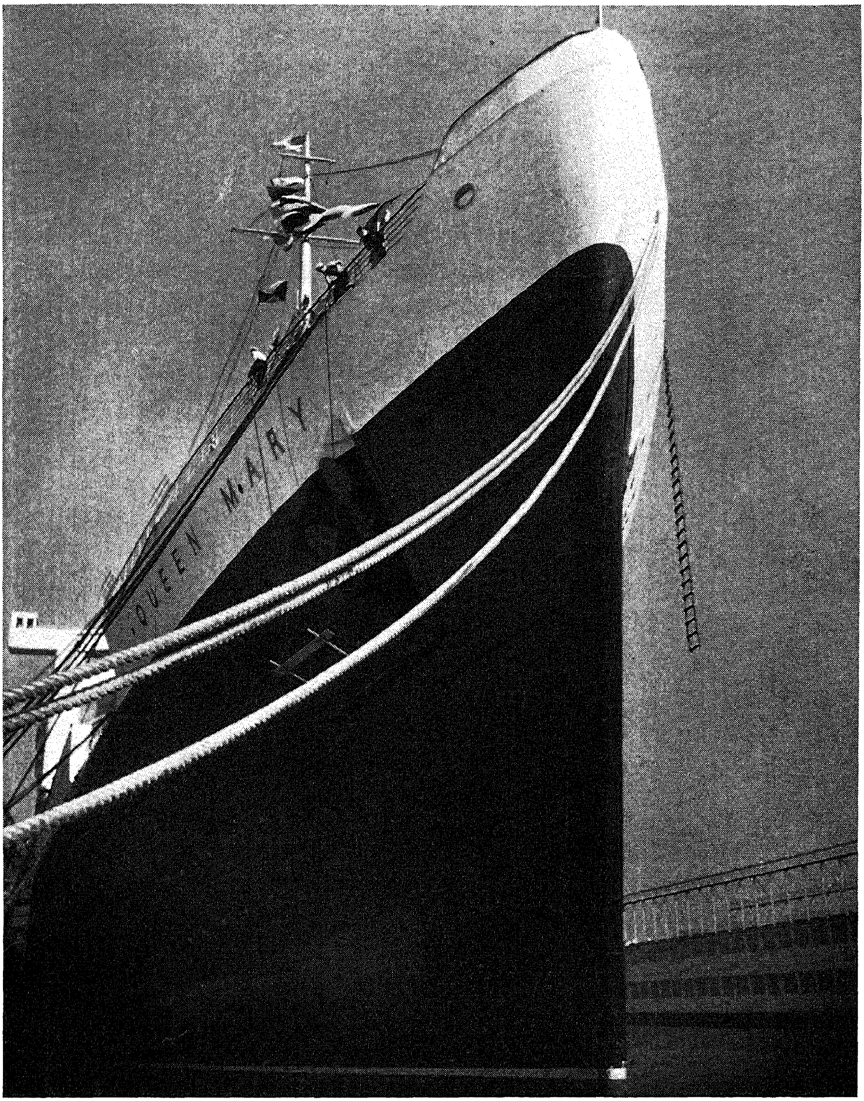
The modern lens in the hands of a sympathetic and understanding person is an all-seeing eye whose glance pierces deeply into surprising recesses of nature. It traps a wealth of detail and lays bare great wonders. It often reveals things that the eye cannot see. An athlete jumps over a bar, we press a button, and in an instant that cold matter-of-fact crystal eye has caught him in mid-air. We are surprised. A horse runs at a gallop, and his four legs seem very strange indeed. The eye has failed to see it, but the camera has caught something that must have been there.

And here we find some oil on the surface of water, and it catches a glisten of light. What a beautiful design it makes! The human eye can hardly take it in for it is moving rapidly, and what exists at one moment is lost the next. But we have captured it in a flash and we have brought the record home to study. The water has now emptied far into the sea, and the oil on the surface is also long gone, but we hold a fairly good account of something that was once quite beautiful, and we study it and stop to admire it.

The world passes before us in this strange one-way street called time. The traffic is in one direction, from the present to something that very soon becomes the past. It cannot be reversed. The hands cannot turn backward. And the things that we see now we will never see again. We are quite willing to allow the disagreeable to pass and hope these moments may never return. But many things are not disagreeable, and we would be glad to have a record of their passing reflection.

And so, with the aid of that hard crystal eye, we trap a few sensations that we know will never occur again. We snatch away a picture of a fleeting image, an idea, a pattern that surely will never be repeated, a horse making a record, a flower growing in the crevice of a rock, strangers walking in the street, friends laughing with us, scenes far away, and little incidents close to our hearts. All these and many more.

But why should we want to hold a reminder of something that no longer exists? The universe is indeed a large place and very full, and man is a very small creature. And the little pictures that he bothers with seem so trivial. But man is a lonely creature. He lives a life tormented by contradictions. He fears what he does not know, and he feels at home with the things that he knows and understands. His experiences are made up of little moments out of the past, and



Queen Mary — Rudolf Hoffmann

Elmar 35mm lens, f:6.3, 1/40, G filter, Du Pont Superior film.

these little moments, recorded on the mirror of his mind, have widened his perception of life. And so he is at peace when he looks back over the pages that he has recorded from his own existence.

Sometimes these pages are only vaguely in his mind, and sometimes they are pasted into an album. And that is why, no doubt, my friend smiles when he shows me his little book of snapshots of that never-to-be-forgotten camping trip he once made. What miserable snapshots they are; what wretched photography! He has since improved. But he smiles as we turn the pages because they bring back something that is very pleasant. They bring back something that he knows and understands. And he smiles because he feels at home with these memories, and his troubled spirit seems at peace. There is no better reason why the following pages of this handbook should be read very carefully!

But before we press the button we might remember that the two characteristic inventions of our age have been telegraphy and photography. From the telegraph grew the telephone, wireless, and radio. From photography grew an age of bad portraiture, silly snapshots, and vulgar movies. Realism, that stark naked child of our century, fared much better with the electrical inventions. The optical inventions retained a hang-over from our dreamy romantic age. Photographs were made soft and sweet. A bad school of fuzzy photography held the stage for several generations. Perhaps the reason for this is the fact that art is much more conservative than science. A false notion in the mind of man can often be altered by a single experiment, but his aesthetic sense, controlled mainly by his emotions, is slow and difficult to change. Photography, although most startling at first, was very slow to take its place in our realistic age.

In painting, the revolt against sentiment and tradition occurred many years ago. Impressionism came like a blast and recorded a new emotional sense; one which was more harmonious with our age. And long before impressionism and our present-day school of candid-camera photography, distinguished artists used the hard facts of realty as a subject for their art. Daumier, Goya, Gavarni, and Delacroix were only a few of the distinguished names.

Somehow or other it took many years for photography to see the world in the light of these artists. It was stupidly slow. And yet it held great advantages. These advantages are twofold: mechanical, and psychological. Mechanically a photograph can be rapidly multiplied and easily enlarged or reduced. Psychologically it holds a

great advantage over many forms of expression, for a thousand words in the ear will often tell you less than a single glance of the eye, and a photograph speaks in a language that needs no translating. It is upon this psychological factor that a new form of newspaper, printed mainly in pictures, has taken so great a hold upon a vast public.

About ten years ago a definite departure took place in the field of photography. A small precision camera made its appearance. At first glance, it resembled a toy, but on close inspection it was found to have those requirements necessary to become an instrument of expression. It was flexible and could be brought into action quickly. It had a very sharp lens, a good depth of focus, a rapid shutter, and seemed quite complete. It also had several distinct advantages such as a crystal focusing device adapted from the range finder used on guns—the only good I know the War to have accomplished—and it used a strip of regular motion-picture film. As this film is procurable in all civilized parts of the world, and is made with various fine emulsions, it seemed most desirable. With this little instrument forty pictures could be taken upon a single strip of negative in rapid succession. This was a great advantage. All in all, here was the instrument many had been waiting for. This was the machine that could record something that came to the mirror of the mind. For many it opened up a new field of expression. And there were a great many in the world who found this a most natural medium of expression, in fact the only medium that they were capable of. Here was an outlet for pent-up visions. Here was a way to say something eloquently for many who, up till now, had remained inarticulate.

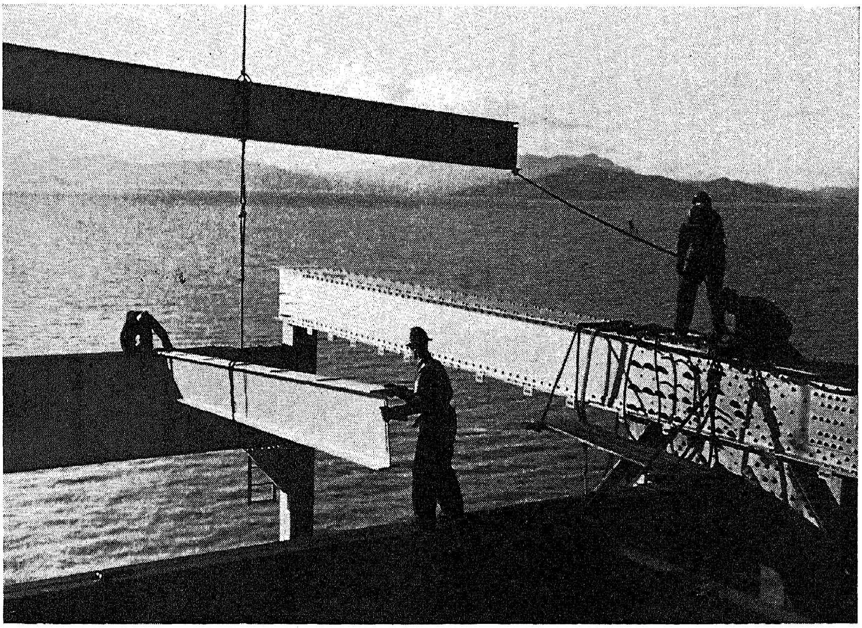
In the ten years that followed, this new field of photography has rapidly come forward. Lenses have been made more rapid, film stock much improved, and special methods for developing and enlarging have been perfected. With the aid of numerous attachments for special work, the little instrument has extended its bounds, as the pages of this volume testify, in a most amazing manner. All this in ten years!

The original camera designed to do this type of work soon found competition. Several are now on the market using motion picture film and equipped with range finders and rapid lenses. Except for a very few special things, this handbook applies equally to all cameras in the miniature field.

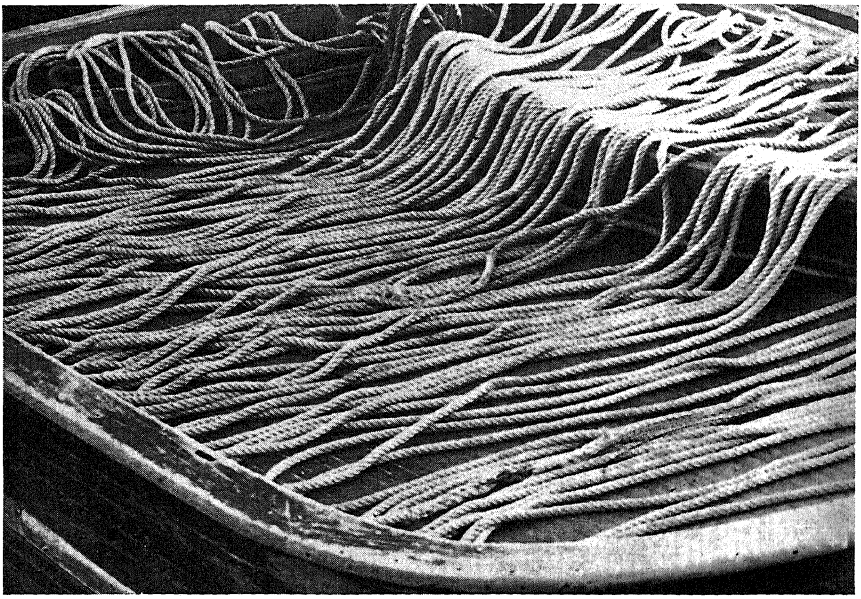
The pages of this volume contain material and data taken from the actual experiences of a group of experts, each a specialist in his field. The information, data and formulas are the very latest that have thus far been perfected. The methods of photography, developing, printing and handling of camera, equipment and accessories, are also the result of very practical experience. Beside this are added some special chapters on Infra-Red, Photomurals, and other fields quite new to this branch of photography. All in all, these covers embrace the most complete knowledge on this subject that is possible, at this time, to present.

The editors have proceeded with a conviction that the traffic of ideas was more important than merchandise. There are no secrets and nothing that they know is withheld or covered up with an air of mystery. They recommend no vast expenditure for equipment or special accessories. But they do ask you to pause a moment before you press the button and acquaint yourself with the instrument and read these pages so that you may know what is to be known in this new field of photography. Knowing is important.

Our age is distinguished by knowing about an infinite multitude of objects. Our existence seems crowded with things. When we select a few of the things about us, we display knowledge. If what we select is pleasing, then we have added an aesthetic sense. And if we compose what we have selected, then we extend the aesthetic sense into something that has a meaning and design. Here creative photography begins. But now one more factor is required: a technical knowledge. And here it is.



Swinging Steel Peter Stackpole



Rope

Manuel Komroff

INTRODUCTION TO LEICA PHOTOGRAPHY

WILLARD D. MORGAN

In 1925 automobiles were on the verge of a metamorphosis into streamlining, the familiar granite ware of our kitchens turned into an array of colors, women smoked on the streets, modern architecture was being championed by Frank Lloyd Wright, Le Corbusier, Richard J. Neutra, and others, a few startling photographs taken at unusual angles appeared in advertisements, the movies were beginning to talk, Eisenstein's Potemkin and other Russian pictures startled movie fans, and the vast majority of photographers were making the same sweet pictures which their grandfathers made in the horse and buggy days. Let me add here that while all this pictorial photography was good in its day and we have profited from the experiences of these earlier photographers it is not sufficient for us today. To continue with the romantic pictorial conceptions is like painting a Rembrandt picture today, or building a Gothic cathedral in the shadow of a New York skyscraper with all its modern steel construction.

Into this teeming world of change there was introduced a small insignificant camera, it looked like a toy, no photographer gave it much of a second thought, true it bore all the stream-lining and modern earmarks of the new age, yet how could such a thing which used only motion picture film be used for serious photographic work—it was called the Leica!

Here was a camera which came as an interpretation of the new developments of the day. A camera which was destined to completely change the photographic conceptions of amateur and professional photographers alike. With the Leica it was possible to secure pictures in places which were formerly taboo for the ordinary camera. Now it is possible to go into court rooms, take actual performance pictures in theaters, and photograph the passing American scene in all its naturalness. During the intervening ten years from 1925 to 1935 the Leica gained thousands of users in every country of the globe. Today the Leica is not only beginning its second great decade

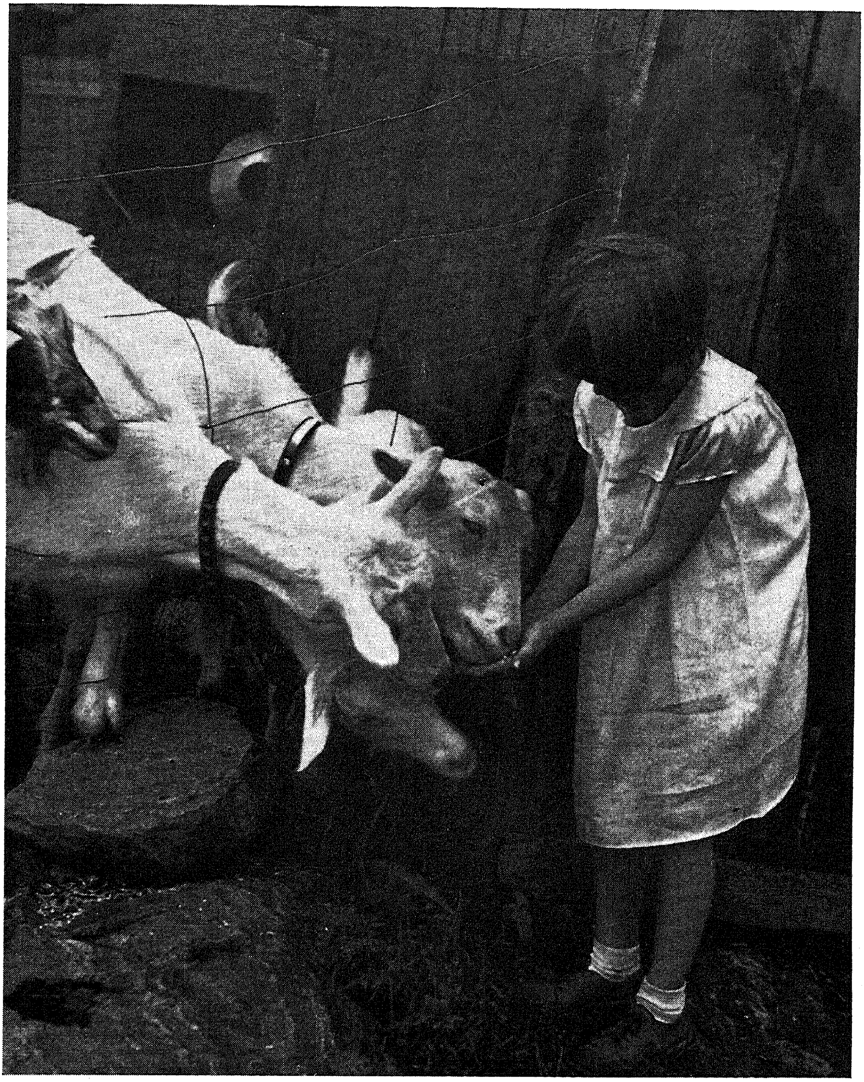
but it is continuing to create new photographic uses and operate in the hands of the beginning photographer as well as the professional. Through the remaining pages of this book fundamental information about using the Leica will be presented and at the same time additional chapters included to give glimpses into more specialized fields where unusual Leica work is already being done.

A New Camera for New Interpretations

It may be true that a modern camera like the Leica in the hands of a photographer who is still thinking from the angle of a 5 x 7 or 8 x 10 view camera will not produce anything very different. But let us use our small camera in a way which will be in keeping with its true functions. The larger cameras gave us the heebe-jeebees when we took a dozen pictures or more because the film costs mounted so rapidly. While with the Leica we are taking yards of exposures on 35mm motion picture film at the rate of eight pictures per foot of film which cost a few pennies. Instead of feeling the usual photographic cramps our small camera gives us freedom of expression, it is our visual note book of passing events. A camera which can be carried in the pocket and used daily has become a necessity like our watch or fountain pen. In this way the Leica can actually enter into our daily living and produce photographs which speak our own language and not the expressions of past decades.

Therefore why make the going difficult by spending all our time striving to make salon prints when the world is teeming with photographic subjects which can be collected through the lens of our Leica camera. A collection of Leica pictures revealing the American scene may have more interest and value than a few laboriously made salon prints. Why not have more fun in making photographs and keep the release button on your camera working overtime.

During the past few years I have had an opportunity to come in contact with thousands of Leica camera users either personally or by correspondence. I have been with them in their triumphs and assisted them in their photographic troubles. World travelers have brought me their pictures, leaders of expeditions have come for advice, and the beginning Leica photographer may ask about the best film or developer to use. I have been in the operating rooms making pictures with doctors, in the air with pilots who want to learn more about this miniature camera, and in industrial plants showing how the Leica can be used to secure pictures for advertising purposes or for use in training salesmen.



Friends
Elmar 50mm lens, f:9, 1/40, Panatomic film.

Rudolf Hoffmann

Out of such experiences I have gathered together the basic ideas now being presented in The Leica Manual. Instead of writing all the chapters myself I felt that a book on this subject would have much more value if various individuals who were doing specialized Leica work could present their own experiences. In this way the present volume has been written and I am certain that it represents something quite different from the usual photographic book. As a reader you will find the very latest information, developments, and technique, covering the entire field of Leica photography.

The majority of us are interested in what may be termed general photography or the making of good pictures which relate to our own lives. To this group I can say that they need not be frightened by the immensity of the Leica field which is covered in this book. A thorough understanding of the basic photographic principles is sufficient for making all the pictures you can ever hope to print. **You only need a Leica with one of the 50mm lenses, an exposure meter, and a good fine grain film to start with.** With such a minimum of equipment you can easily make all the pictures which may be classed in this field of general photography. At first you can have a reliable finisher do your developing and enlarging. However, as your interest in miniature camera work develops you will find that the real pleasure comes when you do your own finishing work. As you expand your interests the more specialized chapters in this book will give you valuable information which comes from the experiences of other actual Leica users.

It should be noted that whenever possible the Leica accessories are included in the chapters which relate directly to the use of these attachments. For example, all the Leica lenses are thoroughly described in the lens chapter, the various copying attachments will be found in the chapter on copying, while the panorama equipment is in a special chapter covering this subject. In this way the Leica Manual becomes a practical handbook for the Leica users who are interested only in general photography as well as for those who are adapting their cameras for more specialized work. Today you may be interested in photographing only general scenes, while next month or next year you will become fascinated with the possibilities in aerial photography or in adapting the Leica to your special hobby or profession. The wealth of information in this book makes it possible to adapt the Leica for use in practically any photographic field.

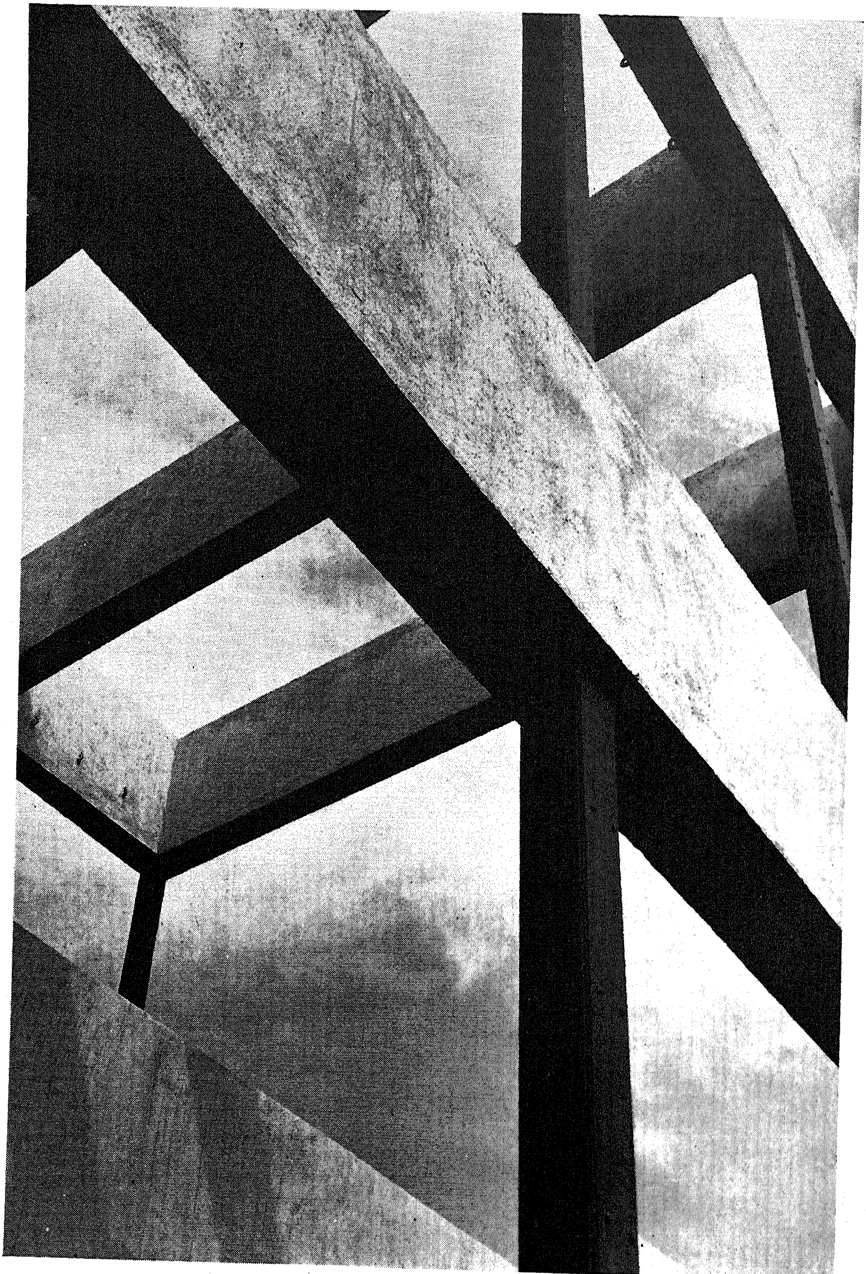
Why Specialized Chapters Were Included

In addition to the more or less standard chapters covering the use of the Leica a few chapters have been included covering more specialized fields such as Eye Photography, Dental, Photomurals, and Photomicrography. Rather than devote many pages to repetition and a résumé of the camera accessories readers of this Manual will undoubtedly appreciate the efforts of the editors to present new and fresh information covering the fascinating field of Leica photography. A careful reading of these specialized chapters will reveal information which can be applied to general photography as well as to the more specialized fields. In addition to being an authoritative manual on the subject of Leica photography, we want this book to serve as an inspiration to every reader by making him aware of the new possibilities in miniature camera photography.

The chapter on Photomurals covers a subject which is entirely new in the miniature camera world. Thus a careful study of this chapter will reveal that photography may express itself in new forms with new ideas in keeping with our more or less complex civilization. Why shouldn't our photographic work interpret our own times instead of slavishly imitating the work of past masters of the camera? The pictorial era in photography which flourished from 1890 to 1925 gave us...atmosphere ...misty landscapes...labored compositions...imitations of the graphic arts and oil paintings...sentimental nudes reclining on rocks in lonesome forests, and prints which had been worked on until they could not be recognized as coming from their own original negatives.

Thus photography became muscle bound with the lavish rules which had to be observed before the photographer hoped to have his picture accepted in the exhibitions. Even to this day we find judges of salons who still cling to the romantic days of photography and discourage the new expressions which are rapidly developing because such pioneers as Alfred Stieglitz, Edward Steichen, Eugene Atget, Edward Weston, Maholy-Nagy, Man Ray, and others felt that photography is an art in itself.

The Editors wish to note in offering this second, revised edition of the LEICA MANUAL that due consideration has been given to the significant advances which have been made in the miniature camera field. New natural color processes, new filters and newly compiled authoritative data on filter factors, a new direct positive enlarging medium, new accessories and lenses, revised and corrected formulas, new information on enlarging papers—were incorporated into this volume. In addition to numerous small revisions and corrections made throughout the book it has been interspersed profusely with new, fresh, and exciting photographs. Having sold over 17,000 copies of the LEICA MANUAL in fifteen months—the Editors are bringing it up to date as the standard reference for all miniature camera photographers. Copies of the LEICA MANUAL have found their way into practically every corner of the globe, no matter how remote or isolated.



Steel and Concrete

Willard D. Morgan

LEICA AND ITS AUXILIARY EQUIPMENT

WILLARD D. MORGAN

CHAPTER I

When we first look at the Leica camera many questions naturally arise regarding its construction, operation, and results which may be expected from its use. Such a small camera as the Leica requires a special technique which is different from other cameras. After all, any camera consists of a lens and a light-tight box containing the film. From this basic principle many cameras have been developed, incorporating hundreds of different special features which tend to make the operation of the camera more easily adapted to special uses.

In the case of the Leica, an entirely new photographic field was entered with such a radical change in camera design that immediately many old habits had to be revised in order to understand the possibilities of miniature camera work. The Leica camera required the use of 35mm motion picture film, the use of fine grain developers, an appreciation of the value of short focal length lenses and their possibilities in securing photographs which were radically different.

As the Leica camera was developed through the various successive stages from the early Model A to the Models B, C, D, E, F and the present Model G with shutter speeds from 1 to 1/1000 second there naturally developed a tremendous interest and demand for information bearing on miniature camera work. Such information assisted in helping all miniature camera users to band together and work in this new photographic field. In fact, many people using the Leica camera actually belong to a fraternity ~~by~~ themselves. Evidence of this fact is to be seen in the numerous miniature camera clubs which have recently been formed as well as the personal interest among small camera users, and the large amount of space given to miniature cameras in the photographic magazines.

In developing the technique of miniature photography, it has been necessary to do considerable experimental work and also produce many written articles covering the important phases of this type of photography which requires a technique unfamiliar to the

average person occasionally using a box camera. Naturally, the users of other than miniature cameras may be confused upon their first introduction to the possibilities of miniature camera photography. They will hear discussions about this and that highly corrected lens, resolving power, circle of confusion, depth of focus, various different orthochromatic and panchromatic films with their advantages and demerits. The religion of fine grain will be ever uppermost.

Although the people who are actually using the miniature camera are deriving immense pleasure from their particular work, it may be that the outsider will look upon such a field as a chaotic world. Miniature camera users will talk about enlarging negatives the size of a postage stamp up to 16 x 20 inches or more. While many workers in this field enjoy the experimental angle, **it is true that over 90% of the miniature camera users are interested in simply producing good photographs.** Most of us make our Leica enlargements either the postcard size or the 5 x 7 inch size. Beyond this size, we enter the field of salon prints or enlargements which may be used for mounting and hanging in the home.

For example, a Leica user in Indiana writes the following after talking with one of the uninitiated miniature camera users:

"About 90% of the camera users of today are not interested in wonders. They do not possess the skill of the expert. They are interested in a camera that will perform well in the hands of the ordinary man in the street, the man who is willing to pay the price of a good camera but lacks the skill of an expert. Does the Leica meet this condition? My opinion is that it surely does."

What to Photograph with a Leica

Photographing with a Leica can be one of the simplest and most effective means of making a perfect negative. On the other hand a Leica user can become so involved with his camera, accessories, and a multitude of ideas about miniature camera photography that he may lose sight of the original idea behind the Leica. **The Leica was produced to simplify photography and make the actual use of this camera so convenient that it would be indispensable.** After all why not use our Leica camera functionally and become familiar with the many intriguing uses to which this camera may be applied.

Before starting to take pictures with our Leica let's stop a moment and become familiar with the photographic possibilities open to the miniature camera user.

1. Because of the small size of the Leica it can be concealed in the pocket and later used for making pictures in practically any place where there is sufficient light to make an exposure. You may catch the unposed positions of people in a railroad waiting room, or the information clerk carefully explaining some route to a customer. The theater, night club, public gatherings, street scenes, and everywhere people meet there will be pictures for the Leica user to make. Such photographs tell their own story, and show in a moment that the photographer must have had a miniature camera and worked quickly in order to make the exposure.
2. Use the Leica for making twenty or thirty successive portraits of the same person and thus catch a more complete interpretation of character. These views will portray a wide range of interesting expressions instead of the usual one-view portraits which are made with the larger cameras.
3. This same idea of making sequence pictures can be used for photographing children who are forever scampering about. Catch these colorful expressions of the youngsters and arrange the resulting pictures in an attractive series in your album.
4. When traveling with the Leica you will find that it is easier to take many more than the ordinary number of pictures and thus give a more complete record of your trip. With the cost of film so small there is no reason why many hundreds of interesting pictures cannot be obtained, even on a short trip of only a few days.
5. At the horse races, athletic events, yacht races, and other similar events the Leica will fit into the occasion without being in the way and thus take the edge off an otherwise glorious time.

There are naturally many other uses for the Leica. One of the pleasures of owning this camera is to discover some of these uses for oneself and thus satisfy one's creative instincts in producing something a little different from "the boys with the big cameras". In this book the writers have endeavored to present their photographic methods as well as to convey some of the pleasures to those who are seeking new discoveries and a more complete understanding of miniature camera photography. To begin with, let's start with the equipment itself.

Know Your Leica

As the Leica has been constructed quite differently from most cameras we should become more familiar with the important working parts. Let's take a Leica in our hands and look at it . . . wind and release the shutter . . . set the speed dial at various stops . . . pull the lens barrel out and lock it by a slight turn to the right . . . turn the focusing mount of the lens and watch the images move out of focus or into focus through the range finder which is coupled with the lens . . . open and close the iris diaphragm of the lens . . . study the depth of focus scale at the base of the lens mount . . . try the slow shutter speeds on the Model F Leica . . . move the counting dial to zero after winding the shutter . . . move the small lever between the winding knob and the time setting dial to **R** or reverse . . . pull up and turn the rewind knob, then push it back into position and change the lever back to **A** or advance . . . adjust the com-

pensating eyepiece of the range finder for distances under 15 feet . . . open the baseplate . . . remove the take up spool and film magazine . . . try loading and unloading several times before replacing the baseplate . . . then go back to winding and clicking the shutter, and at the same time focus on actual objects and imagine that you are making actual pictures.

All this may at first seem complicated but once you have gone through this routine the actual operation of the Leica will seem extremely simple. You will become familiar with a new type of camera which has been built to eliminate the usual amateur photographic troubles, such as double exposures, out of focus pictures, under-exposures because of slow lenses or failure to stop rapid motion because of slow shutter speeds.

To make Leica pictures it is not necessary to own the very latest model camera with all the interchangeable lenses, filters, cases, and a hundred other accessories which could be used. No, all this equipment is for those who can afford it and also for use when they have advanced to the point where more specialized photography is required with the Leica.

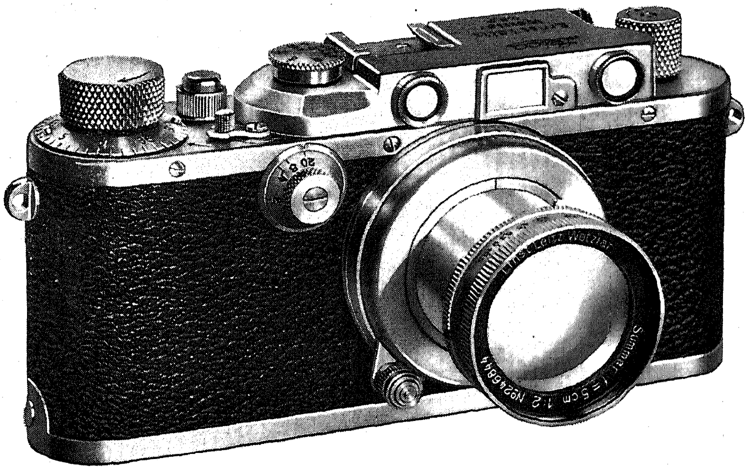


Fig. 7 Leica Model F or G Equipped with 50mm f:2 Summar lens. Model G Available in Chrome Finish Only

Your Beginning Leica Equipment

All you need as a beginning Leica user is: a Leica camera equipped with one of the 50mm lenses, an exposure meter, and

several rolls of film. With this outfit you can take thousands of excellent pictures and never miss the use of additional accessories. Many fine picture are still being made with the early Leica Models A and C. The basic idea of the Leica has never changed since the day it was first introduced in 1924. Therefore it is unnecessary to be disturbed by the haunting thought that it takes a fortune to operate a Leica. On the contrary, once the camera is purchased the operation cost is drastically cut when compared to the larger cameras.

How to Make Your First Leica Picture

When preparing to make your first Leica picture there are a few important points to observe as follows:

1. Place the film magazine containing the unexposed film into the camera after removing the base plate and take up spool. Figure 8 shows the position of the film when properly loaded.

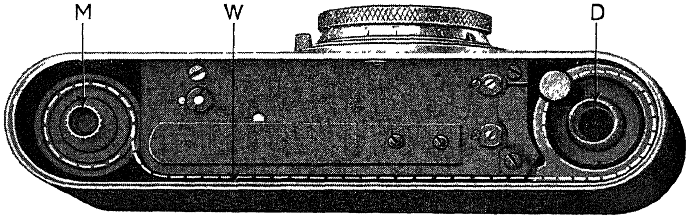


Fig. 8 Dotted Line Shows Correct Position of Film when Loaded in the Leica camera. M—Take up Spool, W—Film, D—Film Magazine

2. Check to make certain that the reversing lever, located between the winding knob and the speed dial, is at **A** or advance. (This lever is moved over to **R** after all the exposures have been made and the film is to be rewound into the original magazine.)
3. Turn the winding knob and click the shutter twice in order to pass the film which was exposed to the light while loading. Then wind the shutter a third time and also set the counting dial at picture number one opposite the small arrow. If preferred the counting dial can be set at zero after the second wind of the shutter. Then after the shutter has been released the camera is ready for making pictures.
4. Determine the correct exposure with the Leicameter, Leicascop or other reliable meter.
5. Set the shutter speed on the dial by slightly lifting and turning to the proper position required. Before setting the shutter speed turn the winding knob one complete turn. In the case of

the Model F Leica the slow speed dial is set at any desired stop between 1 second and 1/20th of a second after the top dial has been set at 20-1 which represents 1/20th to 1 full second on the slow speed dial. When 1/20th is to be used on the Model F set both dials at the figure 20.

6. **Pull out the lens barrel and lock it into position by a slight turn to the right,** in case one of the 50mm lenses is in use.
7. Set the iris diaphragm to the proper opening which has already been determined by using the exposure meter.
8. Secure exact focus by looking through the range finder eyepiece and at the same time rotate the lens barrel back and forth until the two images coincide. (The earlier Models A, C, and E Leica

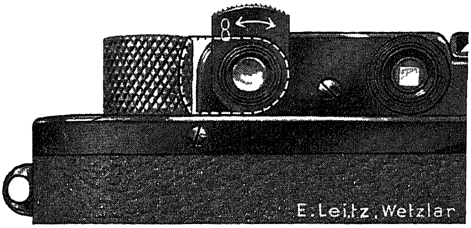


Fig. 9 Rear View of Range Finder and View Finder. Note Magnifying Eyepiece on Range Finder Adjustable for Sharp Focus on Near Objects under 15 Feet When in Upright Position

cameras do not have the built-in range finder with automatic lens coupling as in the later models. However these earlier models may be converted to a later model, or a separate range finder may be used for determining the distances.) When only one image is seen through the range finder the subject is in exact focus. Shift the eye to the right (when holding the camera horizontally) and compose the picture through the view finder. When you are ready to make the picture, press the release button gradually and thus make the exposure. **You have now taken your first Leica picture!**

9. Keep on taking pictures until you have used up the entire roll of 30 or 36 exposures. Try various shutter speeds, outdoor and indoor views. Place your Leica in its case or in your pocket, then see how fast you can whip it into action and at the same time **remember the points which are essential for making a picture.**
    1. Determine the exposure
    2. Pull out and lock the lens into position
    3. Set the lens diaphragm stop
    4. Turn the shutter winding knob one complete turn
    5. Set the shutter speed dial
    6. Look through range finder and determine focus

7. Shift your eye to the view finder and compose picture
8. Gradually press the shutter release button and make the exposure.

10. **Caution** . . . When pressing the release button with the forefinger avoid jerking the camera by abruptly pushing the release. Instead, hold the finger on the release and gradually squeeze the button down, similar to the gradual trigger squeeze which is so essential to accurate shooting with a gun. Place thumb of right hand under the base plate to counteract the downward action of the forefinger. Wherever possible it is best to use shutter speeds of 1/40th or 1/60th of a second or faster when the camera is held in the hands, in order to avoid any possible motion during exposure.
11. When you reach the end of the film roll the shutter winding knob will not turn . . . **don't force it** and try to squeeze another exposure onto the film. Instead, just move the reversing lever to **R** and rewind all the film back into the film chamber. The base of the release button will turn during this procedure and will stop the moment the film pulls away from the take up spool in the camera. The film magazine may be removed from the camera after the winding has been completed and the reversing lever moved back to **A** or advance.
12. Each time the shutter winding knob is turned, when there is film in the camera, the rewinding knob turns in a reverse direction (counterclockwise), thus indicating that the film is properly passing to the next exposure.

Loading the Leica Film Magazine

The standard Leica Film Magazine, sometimes referred to as model B, has been constructed to hold about 5¼ feet of 35mm cine film which is sufficient to make up to 36 double frame exposures, 24 by 36mm in size. This cylindrical magazine contains three parts: the outer shell $\mathbf{B}^1$, the inner shell $\mathbf{B}^2$, and the center spool $\mathbf{B}^3$. The guide groove on the inner shell and the pin inside the outer shell opposite the safety spring, assist in opening and closing the film magazine.

To assemble the magazine first insert the daylight film spool into the inner shell with the tip of the film in the opening of the spool chamber. It is a good plan to bend back the tip end of the film in order to make it easier to pull the film out of the magazine, and also to prevent the film from drawing back into the magazine before loading into the camera. Next, introduce the inner shell with

spool into the outer shell with both rectangular openings together and open. When the inner shell comes to a stop turn it to the left or anti-clockwise until the safety spring clicks into the locked position. Before the chamber is closed pull the film out several inches. The film magazine can only be opened after the safety spring has been slightly lifted and the inner shell turned to the left or clockwise. The inner shell is then withdrawn and the film removed either in the daylight or in the darkroom, depending upon the film packing used.

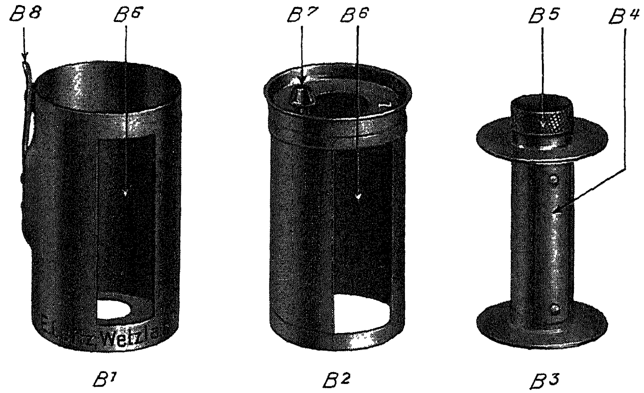
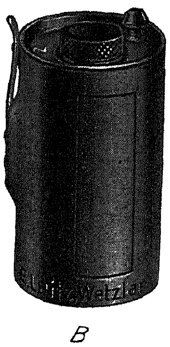


Fig. 10 The Model B Leica Film Magazine.



B = Complete Spool Chamber Model B

B^1 = Outer Shell

B^2 = Inner Shell

B^3 = Center Spool

B^4 = Spring of Center Spool

B^5 = Milled Knob of Center Spool

B^6 = Slots of Spool Chamber

B^7 = Knob of Spool Chamber

B^8 = Safety Spring

The Outside Parts of the Models F and G Leica Cameras

1. **Winding knob**...one complete turn winds shutter, advances film to the next picture, and registers one count on the dial 7 at base of knob.
2. **Shutter release button**...with protective bushing which may be unscrewed and a Wire Release screwed over the release button.
3. **Shutter speed dial**...for setting speeds from 1/20th to 1/500th of a second and time exposure. Dial 10 is used for setting the slower speeds between 1/20th and 1 second. Winding knob 1 must be wound

one complete turn before setting speed dial 3. Once this dial is set it need not be changed for successive exposures unless the shutter speed is to be changed. Leica Model G has an additional shutter speed of 1/1000th of a second.

4. **Clip**...for holding Universal View Finder, Stereo Attachment, Level, Reflecting View Finder, Angle View Finder, and other attachments. A small engraved arrow on one flange of this clip indicates the shutter settings.
5. **Built-in range finder**...which has an interior mechanism connecting with the lens mount for determining correct distances and focus.
6. **Rewinding knob**...which is pulled up and turned to rewind the exposed film back into the film magazine.
7. **Counting dial**...which automatically records each photograph taken. On this counting dial there are two small lugs used for turning the dial, anti-clockwise and against the direction of the arrow on the winding knob, to the zero mark.
8. **Counting arrow**...indicating the number of photographs taken.
9. **Reversing Lever**...which disengages the automatic coupling of film advance and shutter mechanism when the exposed film is to be rewound back into the film magazine. When this lever is set at **R** it operates somewhat similarly to a clutch on an automobile by disconnecting the camera mechanism. Keep the lever at A while making exposures.
10. **Slow shutter speed dial**...which turns to change the shutter speeds between 1/20th and 1 full second. There is also a time exposure setting on this dial.

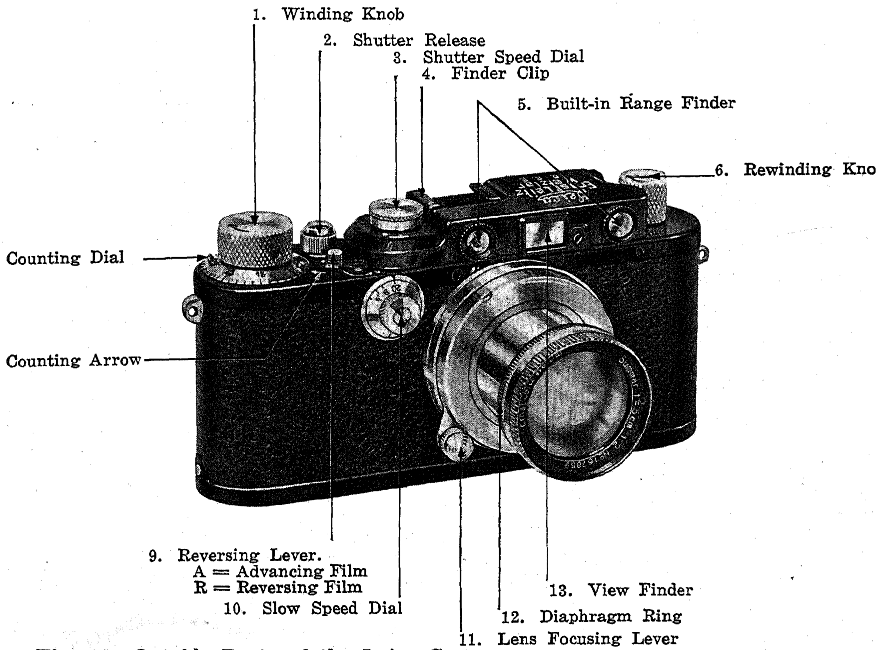


Fig. 11 Outside Parts of the Leica Camera.

11. **Lens focusing lever**...which is pressed, to release the lens mount from the infinity setting, and moved back and forth while the eye looks through the range finder until the double image of an object comes into focus and only one image is to be seen.

12. **Knurled diaphragm ring**...with diaphragm markings which is turned for setting the proper lens opening in the Summar f:2 lens. The 50mm Elmar and Hektor lenses have the diaphragm settings on the front of the lens mount.

13. **View Finder**...which includes the full area of the image registered by the 50mm lenses. The Universal View Finder covers the picture areas of the other Leica lenses.

The Interior Mechanism of the Leica

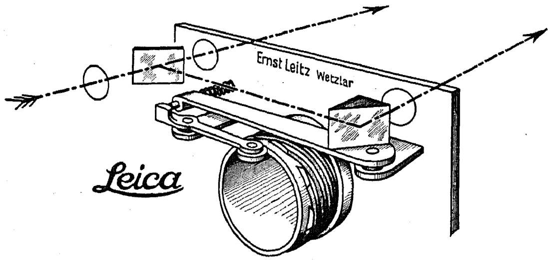


Fig 12. Diagramatical view of the Leica short base built-in range finder. The two arrows point toward the object which will be in exact focus when the image coming through the right hand movable prism is projected and coincides with the image which is seen through the prism mirror on the left. As the lens turns the base of the mount moves in or out and thus moves the small lever which is attached to the right hand prism.

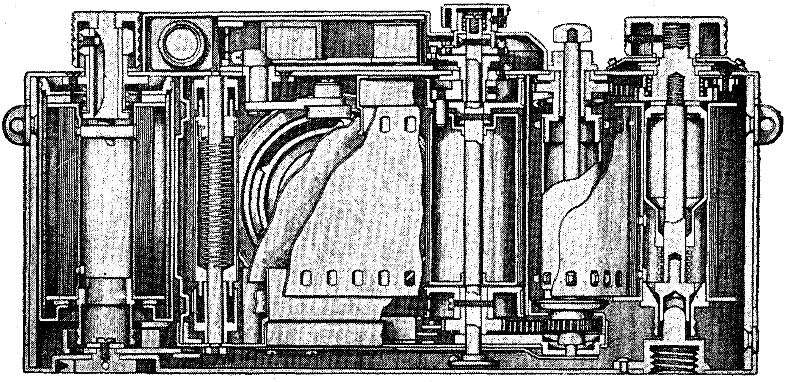


Fig. 13 Back cross-section view of the Leica showing focal plane shutter, film, and all the actual working parts of the camera in cross-section.

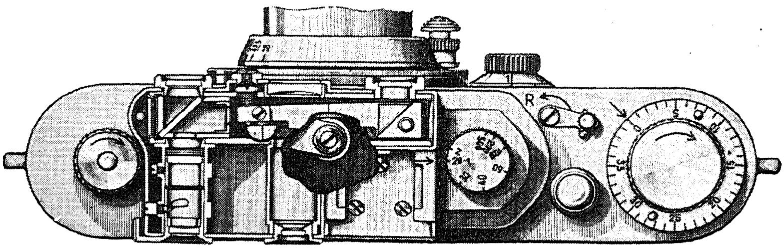


Fig. 14 Looking down on cross-section view of range finder and view finder housing. Note position of range finder prisms, the right prism is moved by the bar which contacts the flange of the rotating lens mount.

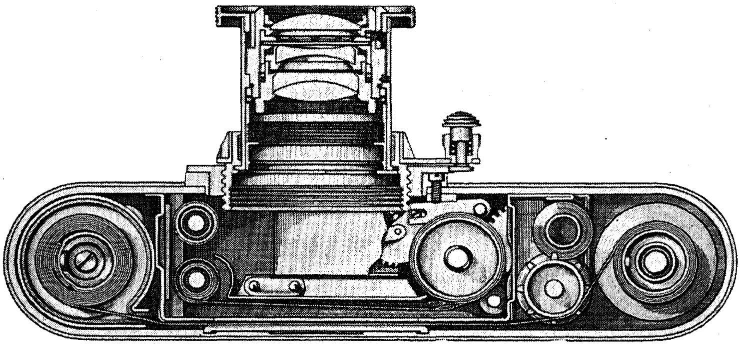


Fig. 15 Top cross section view of the Leica showing position of the film focal plane shutter, lens, and other working parts.

Daylight Loading and Unloading Film Spools

It is more convenient to secure Leica films already loaded in film magazines or on an individual film spool which is inserted into the Leica film magazine when required. The Agfa, Eastman, Gevaert, Mimosa, and

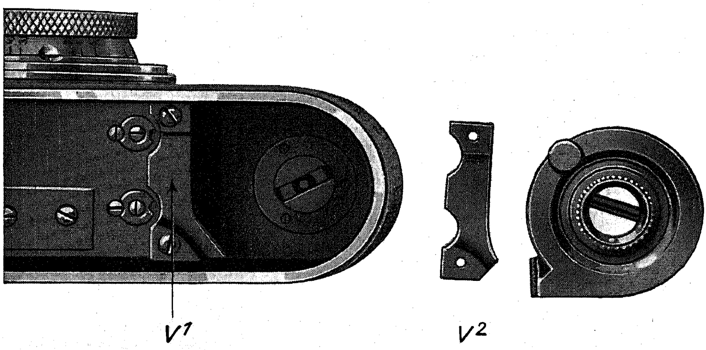


Fig. 16 Showing Method of Inserting the V_2 Lock in the Earlier Leica Models.

Perutz films are packed in complete magazines ready for instant use in the Leica. These film magazines are daylight loading and unloading and greatly simplify the film loading process. Figure 8 shows this type of film cartridge in position.

Some of the earlier Leica cameras may require a slight change as shown in figure 16 before this new type of film cartridge can be inserted. The V_1 lock is replaced by the V_2 lock as shown in the illustration. The change over is done by removing the two screws which hold the V_1 lock in position, and then replacing with the V_2 lock. The V_2 lock may be secured from your Leica dealer.

The Du Pont Leica films are spooled with a black paper leader which protects the film until it is loaded into the metal film magazine and then inserted into the Leica. This film spool may also be unloaded in daylight after the film has been exposed and rewound back onto the spool. Complete directions for loading are packed with each roll of Dupont film.

When the film magazine is to be unloaded in the darkroom the paper leader on the Du Pont film can be cut off after loading into the film magazine. The film end is then inserted directly into the take up spool clip without first winding all the paper leader on the spool before inserting into the camera.

Occasionally one wishes to remove the film roll after half a dozen or more exposures have been made. This may be necessary when a different film is required or when some of the exposed section of the film is to be developed. Before rewinding the film, note the number of exposures taken. Then, after moving the rewind lever to **R**, raise and turn the rewind knob until the film pulls loose...**then stop** in order to prevent the film leader from going back into the film chamber. Remove the film magazine with the two or three inches of the film leader still outside of the magazine. Later this same film roll may be replaced in the camera, winding and clicking the shutter as many times as necessary to move the exposed portion of the film through the camera. The lens cap should naturally be left over the lens during this process.

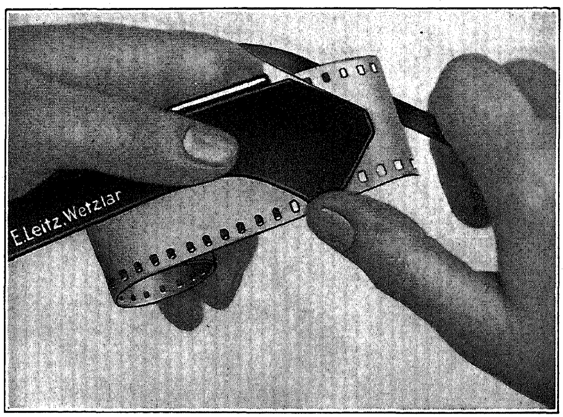


Fig. 17 Method of Cutting Film for Inserting into Magazine Spool

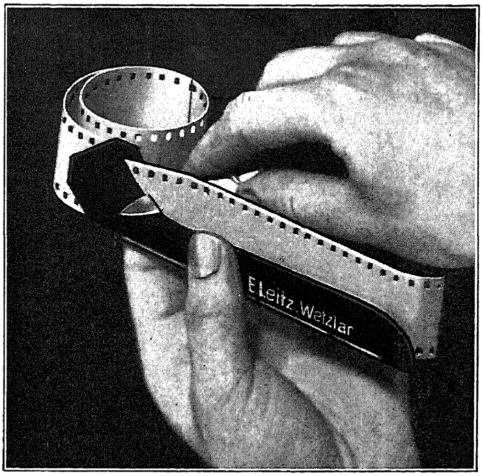


Fig. 18 Method of Cutting Film End Which Projects from Magazine and Inserts into Take Up Spool when Loading the Leica camera.

Loading Bulk Film

Bulk film may be purchased in almost any length from 15 feet to 1000 feet at prices ranging from 2 to 8 cents per foot. As the Leica will expose 8 pictures per foot of film it is an easy matter to figure out the amount of bulk film required after allowing for the few frames which are lost at the beginning and end of each Leica loading.

When loading the Leica film magazine with film from a large roll it is necessary to carry out all operations in complete darkness, unless the proper safety lights are used. In the case of fast panchromatic films complete darkness is essential. Therefore it is best to practice loading the film magazine in daylight with a short piece of film in order to become completely familiar with the operations. You can even shut your eyes during this practicing.

When cutting film from the larger roll care should be taken to correctly taper the end of the film which attaches to the spool and also the leader end which is partly cut away as shown in the illustrations. A Film Trimming Guide is available for this cutting.

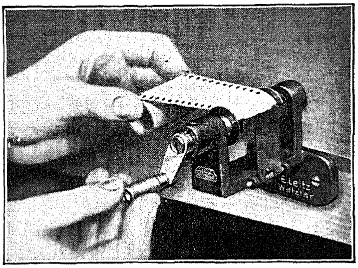
When the Film Trimming Guide is used for cutting the spool end of the film, the guide is opened and the film inserted through the narrow slot with the emulsion side down. Let the end of the film project slightly beyond the end of the guide, close the trimmer and then cut the film as shown in the illustration. **Always make certain that no finger prints are left on the emulsion side of the film.**

Now place the other end of the five foot length of film into the Trimming Guide as shown in figure 18 and make a longer cut in order to make it easier to load the film into the camera later. **It should be noted that no cut is made through a perforation on the film edge.** The Film Trimming Guide has two pins which engage in the perforations and hold the film in the proper cutting position. Place the film into the guide with the emulsion side facing the two pins. The film ends can be cut with a scissors without a Trimming Guide after a little practice.

Winding the Film

In order to make it easier to wind the film spool with fresh unexposed film a Hand Film Winder and also a stationary Mechanical Film Winder are available. The operation of these winders may be studied from the accompanying illustrations. The Hand Film Winder is slipped into the bottom of the center spool and engages the cross-pin for turning.

Fig. 19 Loading Film Spool by Means of a Mechanical Winder. Also for use with Model FF Spools.



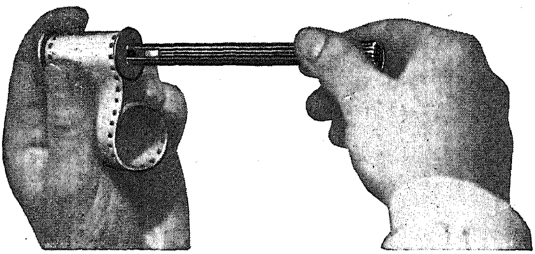


Fig. 20 Hand Film Winder.

The Mechanical Film Winder should be attached to a table or heavy block of wood. A slit core receives the film spool ready for the film winding process. After the film end has been fixed to the center spool, the film should be wound tightly during the turning of the handle. Do not attempt to pull the film and thus tighten the film already rolled on the spool...this will produce scratches.

The Earlier Leica Models

Although the first Leica model was made by Oscar Barnack in 1914 it was not until 1924 that actual production began with the introduction of the Model A Leica without the interchangeable lens feature. This camera contained all the basic features which are to be found in the latest Model F Leica, with the exception of built-in range finder and slow shutter speeds. During the ten years between 1925 and 1935 new improvements on the original design created new models: Thus:

1. A camera with Compur shutter instead of the usual focal plane shutter was introduced as the **Model B Leica.**
2. Interchangeable lenses brought out the **Model C Leica** (also known as Model I).
3. A built-in focusing range finder adapted to couple to the various interchangeable lenses produced the **Model D Leica** (also known as Model II).

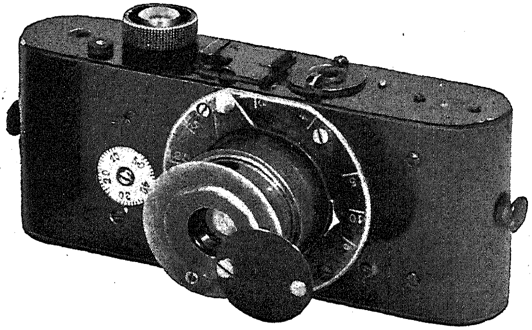


Fig. 21 The Pioneer Leica Constructed in 1914 by Oscar Barnack.

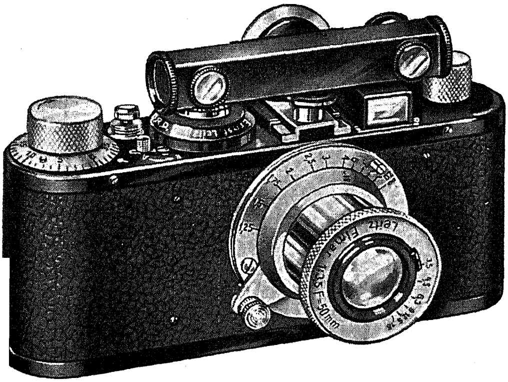


Fig. 22 The Model E Leica with Fokos Range Finder.

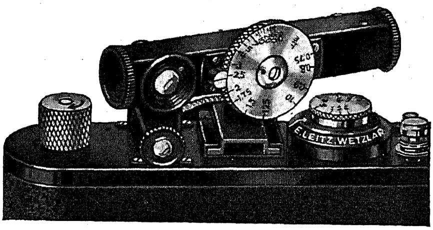


Fig. 23 Detail of Leica Showing Fokos Range Finder in Position. Range Finder may be Turned When Making New Shutter Adjustments.

4. A horizontal Short Base Range Finder and the pull-up type of rewind knob identify the **Model E Leica** (similar to Model I).

5. An additional slow shutter speed mechanism, with speeds down to 1 full second, was added to the Model D type and thus created the **Model F Leica** (also known as the Model III).

6. By the addition of a 1/1000th of a second shutter speed the present **Model G Leica** (also known as the Model IIIa) was produced.

Note. Outside of the United States the Model C Leica is known as Model I, the Model D as Model II, the Model F as Model III, the Model G as Model IIIa, and the Model FF as the 250 Exposure Leica. It will be noted that the original Model A Leica was simply known as the Leica Camera without a model number.

7. With the addition of film chambers to hold up to 33 feet of film 250 Exposure Model FF Leica was introduced.

8. Finally, the Single Exposure Leica was made to meet special requirements.

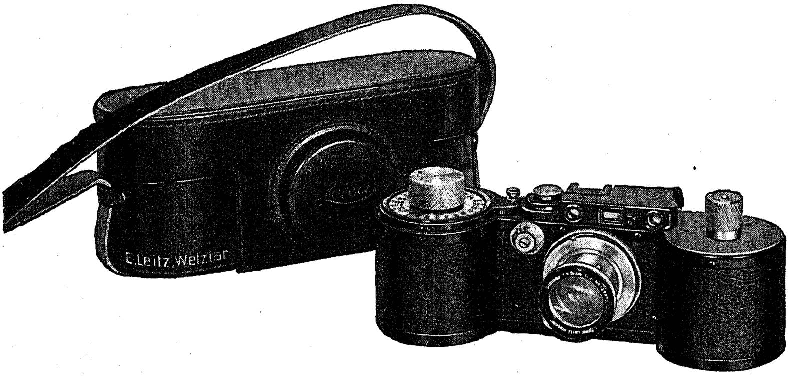


Fig. 24 The 250 Exposure Leica Model FF.

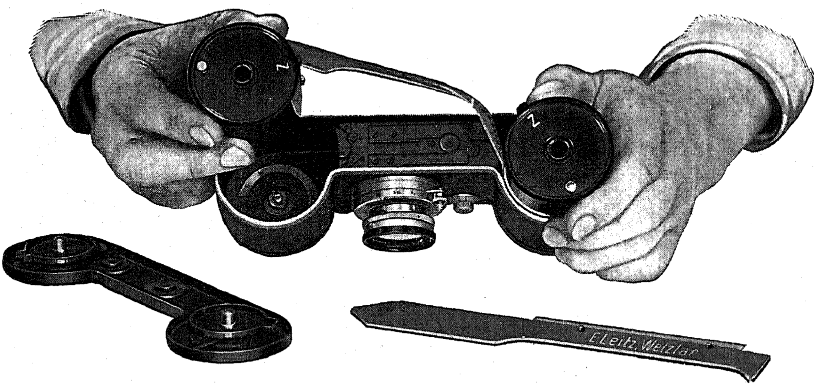


Fig. 25 Loading the Leica Model FF. After Exposures Have Been Made Film is not Rewound. Note Special Film Trimming Guide.

This brief summary of the various Leica models will be of special value to many people who intend to purchase either new or used Leica cameras. The latest direction book which is supplied with every new

camera contains information about the operation of the Leica. This information can be applied to all Leica models. Therefore it will not be necessary to reprint detailed descriptions and directions on these cameras. One of the remarkable features of the Leica is the fact that it is possible to convert any of the earlier models to the very latest model. This fact alone is really a tribute to the inventor who was able to design the basic features of the Leica so perfectly.

Leica Accessories

Along with the development of the Leica there naturally came the production of many accessories which served to extend the use of the camera into many new photographic fields. With the introduction of various interchangeable lenses there was a need for the Vidom Universal View Finder. The various enlargers made it possible for the average amateur to make excellent enlargements from his Leica negatives. Stereo, copy, micro, panorama, and other attachments came in rapid succession to round out the universal use of this camera. Most of these accessories are carefully described in the various chapters to which they relate. However a few of the important accessories not illustrated elsewhere in this book are shown in this chapter.

Vidom Universal View Finder

As the direct optical view finder in the Leica is only used for the 50mm lenses it is necessary to use the Vidom Universal View Finder for all other interchangeable Leica lenses. This finder contains an adjustable diaphragm which is easily moved by turning a calibrated ring to include the field of view of any Leica lens. The diaphragm is rectangular and the sides retain the standard 2 to 3 proportion of the Leica negative size when changed for any field of view. Thus if the Vidom Finder is used with a 90mm lens the calibrated ring is turned to the figure 9 (opposite the long line) and the adjustable diaphragm will then include the exact field of view between 30 feet and infinity. When taking close-up pictures between

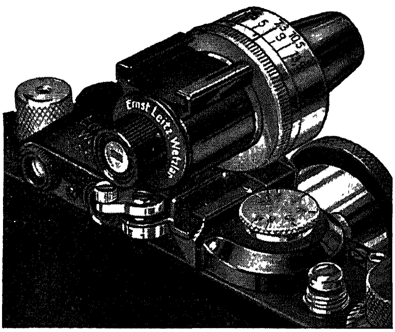


Fig. 26 Vidom Universal View Finder Used for Determining Field of View of the Various Leica Lenses.

$3\frac{1}{2}$ to 6 feet set the figure representing the focal length of the lens opposite the short line on the finder. For distances between 6 and 30 feet set the figure between the two index lines.

A parallax adjusting lever is located at the rear base of the Vidom Finder with calibrations of $3\frac{1}{2}$, 5, 7, 15 feet, and ∞ or infinity. As the finder is attached to the top of the Leica and not directly behind the lens this parallax adjusting lever is used to make the proper inclination of the finder in order to include the exact field covered by the lens. Thus this finder is used by many Leica owners for taking close-up photos with the 50mm lenses. The direct view finder already attached to the Leica does not have this parallax adjusting feature.

The eyepiece of the Vidom Finder rotates in a 90 degree arc in order to keep the image right side up when using the camera in the horizontal or vertical positions. When using this finder to photograph rapidly moving objects it is best to keep both eyes open in order to make it easier to keep the object in the center of the finder.

Another valuable use of the Universal Finder is in determining the field of view in pictorial photography without the camera. By sighting through the finder one can easily determine if there is a picture worth taking without the necessity of removing the camera from the case. Such a convenience is of special value when working with the longer focal length lenses.

Wide Angle View Finder

Although the Universal View Finder includes the field of the 35mm wide angle lens there are times when the smaller wide angle direct view finder is used. This wide angle finder is about the same size as the 50mm finder on the Leica, with the exception that it covers the 35mm lens field. Leica users will find this Wide Angle Finder very useful when the 35mm lens is to be used a great deal, because the camera and additional view finder can easily be slipped into a pocket when not in use.

Rasuk Direct Vision View Finder

A non-optical direct view finder, known as the Rasuk, is recommended for certain types of sport, newspaper, theatre, and general pictures. This finder consists of a rotating metal masking frame and a peep sight for centering the images. A removable reducing mask is used with the 105mm and 135mm lenses. When this mask is removed the frames cover the fields of view included in the 35mm, 50mm, 73mm, and 90mm lenses.

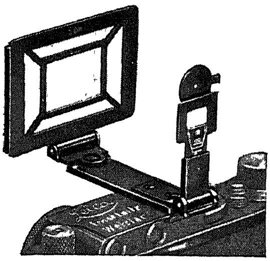


Fig. 27 Direct Vision Frame Finder Attached to Leica.

The rear peep sight has a small rectangular opening for use with all lenses except the 105mm and the 135mm lenses. A small round peep sight is moved into position for using the Rasuk Finder with these 105mm and 135mm lenses.

The rear sighting frame can be slightly raised or lowered for obtaining the proper parallax adjustments. There are three engraved marks of 3½, 7, and ∞ (infinity). For close-up pictures between 3½ and 7 feet the parallax adjustment is quite necessary in order to include the exact field of view. Leica users who wear glasses may find this finder of special value as it may be a little easier to follow the objects and properly frame the picture. With a little practice both eyes may be left open when the Rasuk Finder is in use. This is of particular value when following a fast moving object. With both eyes open the object may be seen very quickly before it comes into the field of view for photographing, and thus the final picture will be taken with the object in the correct position.

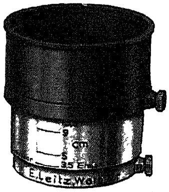


Fig. 28 Adjustable Lens Shade.

Fig. 29 Regular Lens Shade.

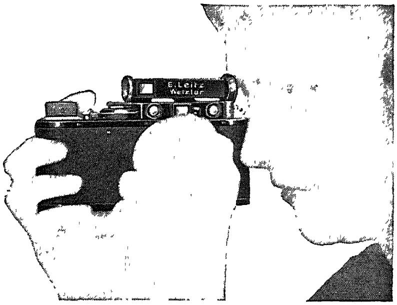


Fig. 30 Wintu Angle View Finder.

The Wintu Angle View Finder

We are all familiar with the way in which most pictures are taken by pointing the camera directly towards the subject with the operator also facing in the same direction. By using the Wintu Angle View Finder the conventional picture taking methods are abandoned with the Leica held at a right angle to the direction in which the operator is facing. In other words, you can take the picture around a corner and not attract attention or have the people, to be included in the picture, assume unnatural poses or expressions. This finder is also of particular value for making candid camera pictures.

To mount the Angle View Finder on the Leica it is only necessary to slip the metal bracket into the clip on top of the Leica, then move the small angle prism over the range finder eye-piece. By sighting through the small angle prism the object can be quickly focused when using the Model D or F Leica with the built-in range finder. After focus is secured shift the eye to the eye-piece of the Angle View Finder.

There is also an Angle View Finder (Winko), without the angle prism, for use with the Leica Models A, C, and E. With a little practice an Angle View Finder will be of great value to the traveler, candid camera worker, and the general photographer.

Sunshades and Their Use

Whenever possible it is advisable to use a sunshade or lens hood on the Leica lenses. Such protection eliminates any possibility of stray light from entering the lens and thus causing a slight halation on the film. This fact is true of any photographic lens, and the larger the aperture the more important it is to use a lens shade to cut off the strong side lights which have no photographic value.

There are numerous lens shades available for the Leica camera. Leitz produces a small metal sunshade for the 35mm and 50mm lenses. An adjustable shade is made for the longer focal length lenses, with the exception of the 73mm and 105mm lenses which are already supplied with their own shades. This adjustable shade has engraved markings for each focal length, and the proper setting is quickly made.

Correction Lenses for Range Finder and View Finder

Persons who wear eyeglasses find it difficult at times to focus with the aid of the range finder or to see the entire field in the view finder, because the eyeglasses prevent them from placing their eyes close to the camera. This difficulty can be overcome by the use of special Correction Lenses on the eye lenses of both the range finder and view finder.

The Correction Lenses embody the same correction as that contained in the eyeglasses worn by the Leica user. When these special lenses are placed both on the view finder and the range finder, it is not necessary to wear eyeglasses and the eye can be placed close to the camera. The Leitz Co. has in stock the necessary Correction Lenses to correct nearsightedness and far-sightedness (myopia and hyperopia). It is but necessary to obtain the prescription of one's eyeglasses from the optician or optometrist and the proper Correction Lenses will be supplied. These screw into the eye lenses of both the range finder and the view finder.

Special lenses to correct astigmatism are also obtainable. However, it is necessary to secure them on special order. In this case the prescription for the eyeglasses must also be furnished.

When to Use the Wire Cable Release

When making either time or instantaneous exposure the Wire Shutter Release is of special value. For example, this release is indispensable for making exposures in photomicrography, all types of close-up copy work, and wherever exposures are to be made where it is essential not to jar the camera. The Wire Release is screwed over the release button of the Leica after the metal protective bushing has been unscrewed.

When it is advisable to operate the Leica at a distance of 10 or 20 feet the longer corresponding wire releases are recommended. For example, the 20 foot release may be used to release the Leica shutter after the camera has been set to photograph a bird or possibly when the photographer wishes to be included in the picture.

Slow Timing Device

Owners of the Leica Models A, C, E, and D may adapt their cameras to the slower shutter speeds between 1/20th and 1 second by using the Slow Timing Device. As it is cheaper to secure one of these attachments than to have these earlier Leica models converted to the Model F, there is a definite advantage in using one of these Slow Timers.

This Slow Timing Device is screwed directly to the release button of the Leica. To operate: wind the shutter of the Leica and set the shutter speed dial to Z the same as for a time exposure. Next, set the Slow Timer by turning the two knobs of the Timer clockwise until the dial comes to a stop. To set for the proper speed lift the longer part of the metal band slightly and turn back or forth until the index line at its outer edge points toward the speed required.

The shutter is released by pressing the release button, located on the side of the Timer, either with the finger or a Wire Release. Press the release down slowly and hold the finger there until the shutter has opened and closed, in order to avoid shaking the camera during the short moment when the shutter is open.

On some of the older cameras the release button varies slightly in height, thus it may be necessary to make a slight adjustment on the Slow Timer before it will operate correctly. To make this adjustment simply use a screw driver and turn the large screw head, located in the hollow shaft of the Timer, to the right or left until the proper release is secured If the release button of the camera is too low the adjusting screw of the Slow Timer may not have sufficient pressure upon the shutter release button...in this case the screw is turned anti-clockwise. If the button is too high, the rotating levers in the attachment do not work properly, consequently the shutter opens only half way and remains open. In such a case the adjusting screw is turned clockwise. Once the proper adjustment has been made for your camera the Timer will need no additional change.

Rapid Winder

There are many occasions when the Leica user may wish to take successive pictures within a very short period of time in order to record continuous actions. The Rapid Winder has been made to serve this purpose. With this attachment extremely interesting picture series may be made of dancers, animals at play or running, children, wrestlers, and rapidly moving objects of all kinds.

The Leica Rapid Winder replaces the base plate of the Leica camera. A trigger is pulled after each exposure is made. This trigger action causes the film to be wound and the shutter set at the same moment. With Leica Cameras from serial No. 1, up to and including No. 111,449, the small pin which holds on the base plate must be changed to a larger pin to accommodate the Rapid Winder which also necessitates a new base plate. A new winding spindle and winding knob must also be supplied as these cameras are not equipped with a notched winding shaft. Cameras numbering from 111,449 up to and including 159,000 must be supplied with a new winding shaft and knob for the shaft. A special Rapid Winder for use on all Leica cameras with serial numbers below 159,000 is available in case the camera is not to be changed.

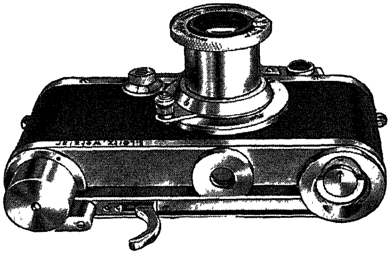


Fig. 32 New type Rapid Winder with trigger action which fits over base of Leica.

Protective Cases for Leica Equipment

All Leica equipment should be kept in protective cases when not in use. Such protection will keep your equipment looking better and also prevent the camera or lenses from receiving scratches or hard knocks.

Sand and dust will be kept out. Too much emphasis cannot be laid upon the importance of keeping all Leica equipment neatly fitted in their proper cases.

There are Eveready cases for the camera only. Soft leather cases for the Camera only and for individual lenses. Then there are a number of combination cases available for the camera, additional lenses, and other extra equipment such as filters, view finders, and extra film magazines. All color filters should likewise be kept in soft leather cases or the original filter box to prevent scratching and the collection of dirt on the glass surface.

Optical Short Distance Focusing Device "Nooky"

This new and ingenious attachment extends the usefulness of the automatic focusing principle of the Leica beyond its present range. Heretofore the shortest distance for which the setting of the lens could be secured automatically was $3\frac{1}{2}$ feet. By unscrewing the lens from the camera and screwing the "Nooky" into its place, and subsequently attaching the lens by its lugs to it, sharp focus can be instantly secured on all objects from approximately 40 inches to within 18 inches of the camera.

The "Nooky" attachment can be used on models D, F, FF and G Leica Cameras. It is intended for use with 50mm lenses and as this issue goes to press, it is available for the Elmar 50mm lens. Later it will become available in models for other 50mm lenses.

In using this device outdoors, as for details of plants, flowers and insects, one should focus quite critically and take care that in shifting the eye from the range-finder to the view-finder the camera should not be moved out of focus. When you are only 18 inches away from your object the movement of an inch forward or backward makes a difference. Outdoors as well as indoors stop down as much as you are able to take in the fullest depth possible, and allow for any error in focusing.

A framing mask is incorporated into the optical range finder part of this device which ingeniously and automatically compensates for the shift of the field due to parallax.

At the short distances for which this attachment is intended

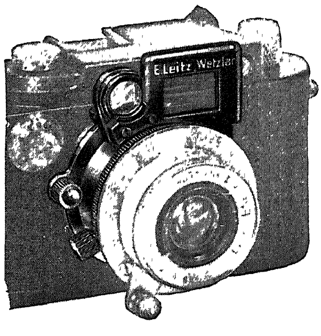
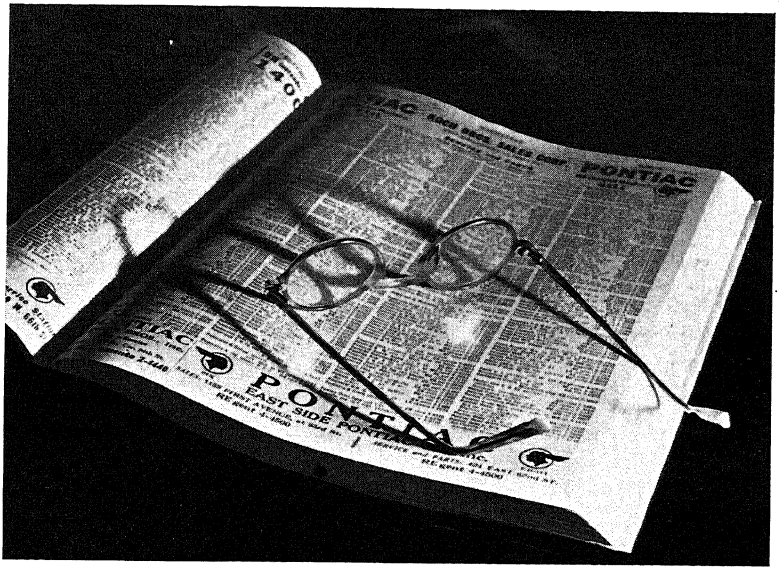


Fig. 34 Optical Short Distance Focusing Device "Nooky"



"Small Print" — Manuel Komroff
Elmar 50mm with "Nooky" 2 sec. f:12.5 Panatomic film—Harvey Developer.

the depth of focus is obviously very small. It is extremely important in focusing the lens to employ only the center of the field measured through the range finder when the double edge of the framing mask enters the field of vision. Unless very short exposures are called for due to inadequate illumination it is important to stop down the aperture of the lens to at least f:4.5 to increase its depth of focus. The following table gives the approximate depth of focus at the various settings of the lenses and at various distances as well as approximate size of the field covered at the various distances:

DISTANCE: Object to lens Inches	DEPTH OF FOCUS AT LENS STOPS: f: 3.5	4.5	6.3	9	12.5	18	APPROXIMATE FIELD COVERED: Inches
	Inches						
39½	3½	4¼	5¾	9	12¾	18½	16½ x 24¾
35½	2½	3¼	4½	6½	9	13¼	14½ x 21¾
31½	1¾	2½	3½	5	7	10¼	12¾ x 19¼
27½	1½	1¾	2½	3¾	5¼	7½	10¾ x 16¼
23½	1	1¼	1¾	2½	3½	5½	9 x 13½
19¾	½	¾	1¼	1¾	2½	3½	7¼ x 10¾
17¾	¼	½	1	1¼	2	2¾	6¼ x 9½

Above figures are rounded off to nearest ¼″.

Single Exposure Leica

Recently the Single Exposure Leica was introduced to meet the demand for making single negatives instead of the strip of exposures on the ordinary roll of Leica films. This camera consists of a small housing which is the exact depth, from lens flange to film surface, as the regular Leica camera models. A removable ground glass plate, film holder, and one of the Leica lenses completes the outfit. Some of the advantages and uses of this camera may be mentioned as follows:

1. **Used as a lens tester.** The distance between lens flange and ground glass is 28.8mm which is exactly the same as the distance between the lens flange and film surface in the regular Leica models. The exact field of view of the various lenses can be quickly checked by focusing the images upon the ground glass of the single Exposure Camera.

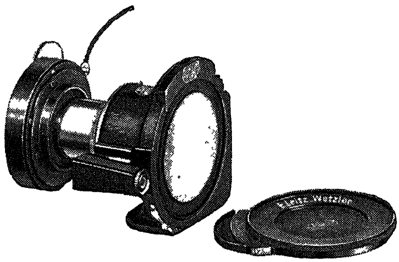


Fig. 35 Single Exposure Leica. Note Film Holder, View Finder and Shutter.

2. **For use in photomicrography.** Single micro pictures can be quickly made with this camera and developed in a small tray either for testing exposure, filters, or for making permanent records. Use this camera without a lens but with a 6cm extension tube between the Single Exposure Leica and the eyepiece of the microscope, with a black cloth around the tube to exclude stray light. The camera is mounted on a rigid support beside the microscope. Such an arrangement makes a very inexpensive photomicrographic outfit, and insures perfect results.
3. **As a copying camera.** Any type of copy work can be done with this Single Exposure Leica by using an adjustable mounting and the various extension tubes or the front lenses. If desired, it is possible to obtain various fixed distances with the lens which can later be shifted to the regular Leica for making pictures on the longer strip of film.
4. **For making portraits.** It is quite easy to compose portraits on the ground glass of this camera before changing to the film holder and making the exposure. The 1.2cm extension tube can be used for close ups when necessary. If one of the 50mm lenses is used the collapsible feature of the lens barrel can be adapted to obtaining proper focus.
5. Also for general photography where only one picture is to be made at a time, especially where it is necessary to test exposures, color filters, and films before using the regular Leica camera.

To set up and operate the Single Exposure Leica proceed as follows:

1. Attach the camera to a tripod, Sliding Arm on the copy attachment, or any other rigid support.
2. Screw in one of the interchangeable Leica lenses and fit the Ibsor

shutter over the front of any lens except the 73mm which has a diameter larger than the others. If the Ibsor shutter does not fit tightly, simply press down the cut flange until a tight fit is secured over the lens.

3. Attach the wire cable release. Usually there is a small pin which comes attached to the shutter; this is used for making exposures by setting the shutter and inserting the pin into the small hole on the face of the shutter, and then removing the finger from the shutter setting lever. The shutter remains closed, but the moment the pin is withdrawn the shutter will open and close at the proper speed setting. A string can be attached to the pin so that the operator can easily get into his own picture after pulling out the stop pin and making the exposure.
4. Next see that the ground glass is clipped into position with the ground side of the glass facing toward the lens. Then secure the proper focus by moving the lens mount around and watching the image on the ground glass.
5. When exact focus has been secured replace the ground glass with the single film holder. **Pull out the dark slide** covering the film. Make certain that the shutter is not open over the lens while withdrawing the slide. Then make the exposure, replace the slide, and remove the film holder.

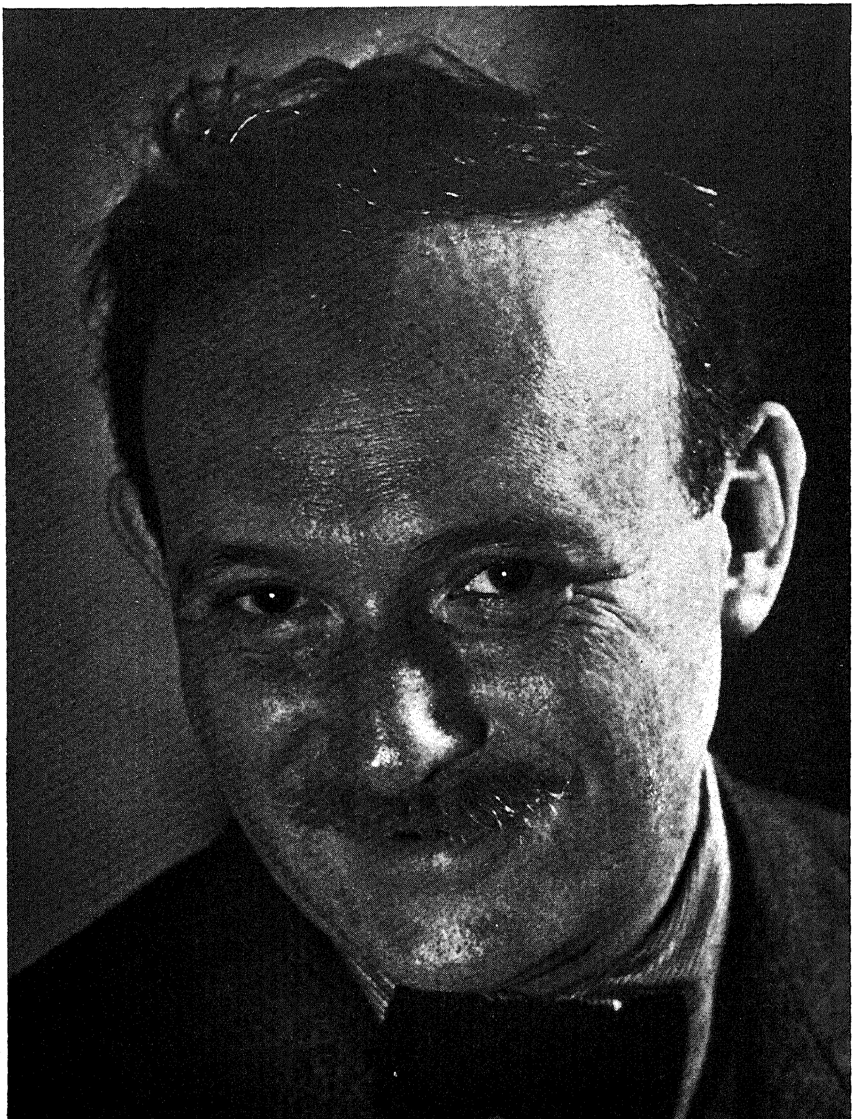
When preparing the single cut films for this camera it is a good idea to wind the 35mm film in an opposite direction, with the emulsion side out, and left that way for a few hours or several days before using. After this treatment it will be found that the film lies much flatter and it is easier to cut into single exposure lengths. It is also advisable to cut all the film required at one time and keep the pieces between single black papers in a light-tight box or envelope until used.

Use the width of the dark slide as a guide for cutting each individual film. The width of this slide is the exact length of the film for one single exposure in this camera.

Development of these single films can be carried out in a small tray.

Summary

Many other accessories for the Leica camera will be described in the following chapters. There are also many circulars giving directions and booklets available from the Leitz Company on the various Leica attachments. Directions are supplied with every accessory when purchased. Therefore the greatest emphasis in this book has been laid upon the actual use of these accessories. The reader is invited to carefully study all of the following chapters, even though he may be interested in only one or two subjects. By reading about the way in which the Leica is applied to other uses, it is possible to pick up many suggestions which can be applied to one's own particular field of Leica photography. Also by reading these various chapters you will obtain a more complete idea about the scope of the Leica and thus be able to understand and offer suggestions to your Leica associates who may be working in these more or less specialized fields of photography.



Manuel Komroff

Harold Harvey

LEICA LENSES

H. W. ZIELER **CHAPTER 2**

"What kind of a gadget is this? Is it a movie?"

"No, it is a little camera. Did you ever hear of the *Leica?*"

"Oh yes—so, this is a *Leica;* it certainly is a compact little thing! How large a picture can you take with it?"

"The pictures are not much larger than a postage stamp; but you can enlarge them to almost unbelievable sizes."

"Gee whiz—it must have a marvelous lens!"

Why does everybody think at once of the lens when he sees a miniature camera? Why must a small camera have a particularly good lens? What properties characterize a good lens? What does the lens have to accomplish and how well does it succeed? How can you use your lens equipment to best advantage and why may you want to have several lenses?

When miniature photography was in its infancy, there were many sceptics who pointed out that an enlargement can never be as sharp as a contact print; and since the small negative must always be enlarged considerably, the loss of detail, it seemed, ought to be so great that the enlargement would be of little value.

Practice soon gave ample proof to the contrary. But practice alone is often considered as insufficient proof because you may have to use all kinds of tricks which only the expert knows. To set our mind at ease about the possibilities of miniature cameras we may start our investigation about lenses by finding out, how sharp the negatives of miniature cameras are. It is true that an enlargement must always be less sharp than the original negative because the same detail is stretched over a larger area. Still it is quite possible that we may not be able to detect any difference.

Suppose we have before us two pages covered with printed matter. Some clever printer may have been able to make the letters on one page as small as 1/500th of an inch. But the second page may have letters as small as 1/1000th of an inch. We hold these two pages as far away from the eye as we would hold a moderately sized photograph. Of course, we would not be able to read these pages.

We would not even be able to see from this distance which of the two pages has the smaller letters.

The capacity of the human eye to make detail distinguishable or, *the resolving power* of the human eye, is limited. If we compare two objects as, for instance, a contact print and an enlargement, the former having detail ten times smaller than the resolving power of the eye and the latter having detail which is only three times smaller than this limit, we may not be able to detect any difference in sharpness.

The limit of resolving power of the human eye has been determined by experiment and calculation. It is customary to express it by the magnitude of the smallest detail **in the object** which can still be *resolved.* This magnitude depends, of course, upon the distance from which we view this object. If we want to see finer detail, we move the object closer to the eye. But the *angle of vision* under which the finest resolvable detail appears, always remains the same. Thus it has been found that, allowing for slight variation of individual power of vision, the limit of resolving power of the human eye is about 2 to 3 minutes of arc. That means that in an object held about ten inches from the eye we cannot see detail if it is closer together than 1/100th part of an inch. If the object is 20 inches from the eye, the detail must be 2/100ths of an inch apart if we are to distinguish it.

Now we have to investigate how closely the detail can be crowded together in a negative from a miniature camera. This investigation is rather involved and it is to our advantage if we penetrate more deeply into the entire process of the formation of images by lenses

Let us select the simplest object possible: one luminous point Figure 38 shows a diagram of a simple experiment. A lentil-shaped piece of glass is placed at a certain distance from the luminous point **P**

A sector of light of the angular aperture **a** passes through the glass and in doing so it changes its original direction. Each light ray is broken or, in scientific language: refracted. The more obliquely the rays meet the surface of the glass, the more pronounced is the change in direction. By skillfully shaping the piece of glass we may be able to guide each ray in such a manner that, after leaving the lens, the entire bundle of rays converges as a cone of the angular aperture **b** until the rays meet again in **one single point** $\mathbf{P}_1$, which is the image of the original point **P**.* This is the essential principle of

* If we hold a screen in the plane **I-I** we see on it one bright spot $\mathbf{P}_1$

the formation of a *real* image. When photographing a complex object the lens collects diverging bundles of rays from each object point and must unite them in *image points* which must have such location in respect to each other that they reproduce the object in the image plane.

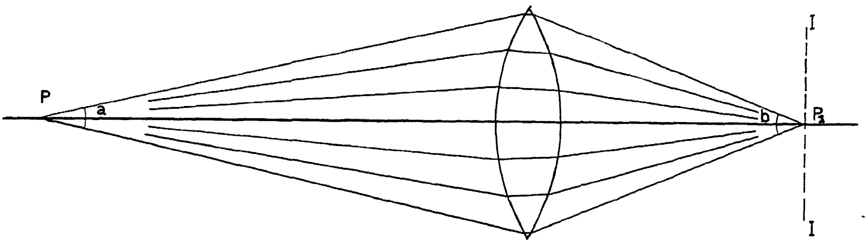


Fig. 38 Formation of a Real Image of a Luminous Point

It is the job of the lens designer to *skillfully shape the lens.* In practice this job is so immensely difficult that we may say, it is impossible to succeed completely. In the first place it is next to impossible to grind and polish accurately enough any surfaces of unusual shape. In fact, in photographic lenses we only find lenses with spherical or plane surfaces. But even if we were not limited in this respect, we would meet with many other difficulties. These light rays are tricky individuals. One single ray of white light, for instance, upon entering the lens, begins to disintegrate into rays of various colors and finally a rainbow colored cone of light leaves the lens. This phenomenon is known as *chromatical aberration.* We also must contend with the fact that if we use spherical lenses, the outsiders, the rays which meet the lens with greatest obliquity, are *bent* too strongly and refuse to come to the same meeting point where the rays of the center of the cone unite. This is known as *spherical aberration.*

There are many more misbehaviors of light rays which give the lens designer a headache. If he wants to guide these rays to the same point he cannot restrict himself to the use of one single lens. He must combine several pieces of glass, selecting different materials and shapes and placing them at accurately determined distances from each other. Thus he creates a photographic objective of the type shown in figure 39 which is the famous Elmar lens of the Leica camera.

You will see the definite plan of construction: a single plano-convex lens is followed by a biconcave lens, placed at a definite dis-

tance from the first. Behind this second *element* there is a pair of lenses cemented together. Each lens has spherical or plane surfaces which in a diagram appear as parts of circles or straight lines. The centers of all these circles lie on one straight line, called *the optical axis.*

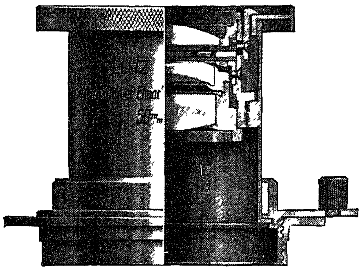


Fig. 39 Cross-section of the Elmar 50mm f:3.5 Lens

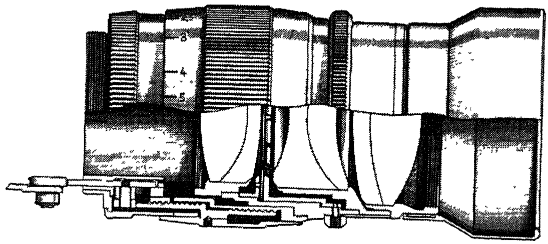


Fig. 40 Cross-section of the Hektor 73mm f:1.9 Lens

There are other types of objectives* such as the Hektor shown in figure 40, the Summar and many others. Each of them is built according to a different plan and represents an effort to make the rays *behave,* but no effort is completely successful. There is always a sacrifice in some respect, as we shall see later.

With one of these objectives we may perform a few interesting experiments. Of course, we cannot actually select as an object one single luminous point. But we may produce a disc of light of a definite and small diameter. Suppose a ground glass is placed before a bright lamp and again before the ground glass an iris diaphragm which can be contracted to very small diameters. Thus we may produce a luminous disc of, say 1/10th of an inch. We place the lens at a certain distance from the light source and on the other side of it we place a screen so that on it the image of the luminous disc appears

* "At this place, I wish to emphasize that I prefer the word 'objective' to the word 'lens', although the latter term is more popular. A lens is really one piece of glass whereas an objective is a compound unit and consists of several lenses."

with maximum sharpness. The conditions may have been so selected that the image has a diameter of 1/200th of an inch. In other words, the image is twenty times smaller than the object. Now we reduce the opening of the iris diaphragm to 1/30th of an inch and the image, again twenty times smaller, is 1/600th of an inch. But as we further reduce the diameter of the luminous disc (perhaps to 1/100th) we find that **the image retains the size of 1/600th inch.**

This is a very important discovery. Suppose we would have two luminous object points, each of them very small, for instance 1/1000th of an inch in diameter, but less than 1/30th of an inch apart. The lens, when forming the image at the same ratio of reduction as before, (20:1) reduces the distance between the images to less than 1/600th but at the same time each of the images occupies 1/600th. The two image discs overlap, melting so to speak into each other. We have now overstepped the limit of resolving power of the lens.

This experiment reveals a very important fact regarding the performance of optical instruments: the image of a theoretical object point is never a point but a light disc of definite, measureable diameter. But if we think that the actual magnitude of this disc can be made smaller and smaller as manufacturing methods and the art of lens designing improves, we are greatly mistaken. Unfortunately there are definite limits which cannot be overstepped and they have their cause in the very nature of light itself.

In a diagram we may indicate a light ray by one straight line, but in reality we find that as light progresses with infinite speed in the direction of this line, very minute vibrations take place with enormous frequency. Physicists have attempted to explain the many strange phenomena which light can produce, by assuming that it propagates like a wave motion. To help our imagination we may make a comparison. Suppose that you throw a stone into a lake. From the center, where the stone hits the surface of the water, we see a wave motion spreading with equal speed in every direction as circles of ever increasing diameter. From crest to crest of successive waves there is always the same distance, called the wave length. This wave length may be small or large. The motion of the waves probably spreads with a speed of several feet or yards a second. But as these waves move away from the center, the surface of the water only moves up and down so that if a piece of wood is swimming on the water, it is carried up and down but not away from the center of the disturbance.

If light proceeds from a luminous point, waves of unbelievably small wave length spread with equal speed in every direction. This speed, however, is very great, almost 200,000 miles per second. The vibrations take place at right angles to the direction of propagation. And, to come back to the formation of the image of a point, where the light is concentrated into the image point, we find an enormous confusion of vibrations from light waves of different lengths and directions. These waves partly interfere with and cancel each other but still they spread the light over a

certain area. In fact, if we would study this area through a microscope, we would find a small disc of light surrounded by rings of light of very weak and rapidly diminishing intensity. This is called a *diffraction pattern.*

We need not penetrate further into these theoretical optical matters. We must only realize that even a theoretically perfect objective has a limited resolving power. This **theoretical** resolving power depends mainly upon the angle of convergence of the cone of light which the lens concentrates (in fig. 38 this cone is marked *b*). **The larger this angle, the smaller is the finest detail which a theoretically perfect objective could reveal.**

But here we can see the difference between theory and practice. It is unfortunate but true that, as we try to make objectives with great light concentrating power, the difficulties which we encounter increase beyond description. These misbehaviors of light: spherical and chromatical aberration and many others, can hardly be held in check. If we are content with a small cone of light, the situation can be controlled quite nicely. A small cone, of course, contains so to speak, only a small amount of light and when photographing we would have to give very long exposures. In this age of speed this would be a serious handicap. Therefore there is a constant race between the manufacturers to produce lenses of greater light concentrating power: but the task before them is very difficult indeed.

The Iris Diaphragm and the Resolving Power

As you know, photographic lenses are equipped with iris diaphragms with which the angular aperture of the cone of light, and therefore also the light intensity in the plane of the image, can be regulated. As we open or close this diaphragm the difference between theory and practice evidences itself as follows:

a. When the iris diaphragm is closed, the difference between theory and practice is least noticeable. At the same time the theoretical resolving power is at its *worst.*

b. As the iris diaphragm is gradually opened, the practical insufficiencies come more and more into the foreground. This does not mean that any practically produceable lens yields the sharpest images when the iris diaphragm is closed. In fact, in a good lens the sharpness will **increase** as we begin to open the iris. **Only, it will not increase as much as can be theoretically expected.**

c. If the iris diaphragm is opened considerably, the misbehaviors of light finally become so noticeable that even **the actual sharpness decreases.**

A good method to judge the quality of a lens is, therefore, to find out how much the iris can be opened with a beneficial effect upon the sharpness, the resolving power, of the lens.

Every photographer should realize the full significance of this fact and should not believe the wrong statement that any lens performs best when the iris is closed as far as possible.

But let us not forget our original question: How sharp is a miniature negative? The actual limit of the resolving power is not

the only factor to consider. We must not forget that the image which the lens has formed is recorded on the film, which is coated with a light-sensitive emulsion. The emulsion is turbid and has a certain thickness. As the light penetrates into the emulsion, it is scattered and the record of the image of one single luminous point upon the film emulsion will necessarily occupy a larger area. Thus the film emulsion introduces a certain loss of sharpness. If we wish to find a quantitative measure for the sharpness of a minature negative we must measure the diameter of the image disc on the emulsion when the object is so small that its image is equal to the limit of resolving power of the lens. This area is often referred to as the *circle of confusion,* because within this circle there is a great confusion of aberrations, diffractions, dispersions and many other misbehaviors of light.

Thus it has been found that the diameter of the *circle of confusion* of the better lenses, such as are used in miniature cameras, does not exceed 1/800th of an inch, even when the diaphragm is open and the practical discrepancies are most apparent. Upon closing the iris diaphragm, the sharpness improves, then retains this optimum value until finally, as the aperture assumes very small values, it decreases slightly.

We learned in the beginning that the smallest detail which the human eye can detect from a distance of 10 inches is about 1/100th of an inch. **If the detail in a miniature negative is crowded into as small a spot as 1/800th it is quite evident that this negative can be enlarged 8 times without noticeable loss of sharpness.**

If you really want to look at the **picture** you will never hold an enlargement of 8 x 10 inches closer than 10 inches from the eye. Only *grain fiends* have a habit of *smelling their pictures,* regardless of size. We, who want to enjoy the pictures which we have taken, have learned that an enlargement may appear as sharp as a contact print and thus we may confidently discard bulky equipment in favor of the small and compact Leica. Its existence is built upon a sound scientific basis and, as far as sharpness of the picture is concerned, we may safely say that for our purposes it is sufficiently equivalent to the large camera.

The Miniature vs Larger Cameras

With this fact established we shall now proceed to find that in other respects the minature camera is definitely and considerably superior to the large camera. Above all, it has reconciled two opposing factors which cannot be mastered with larger cameras: *speed* of the lens and depth of focus in the negative.

You will often have found in photographs that some parts of the picture were sharper than others. Either the objects close to the camera are sharp and those further away appear *fuzzy;* or the background is sharp and the foreground is *out of focus;* or there is a range-in-between which is imaged crisply, whereas the very near and very far objects lack in sharpness. The photographer can, at will, select the range of object distances within which everything is imaged with the best possible sharpness and, if he uses his camera correctly, he can always direct the attention of the spectator to the subject of interest. There is, then, a range within which everything is equally sharp and this range represents the *depth of focus.*

In photographs of general outdoor scenes and many other types of pictures it is highly desirable, if not essential, that the entire picture be in perfect focus. Only in portraits and group pictures it often is of special advantage to reproduce in sharpest focus only the subject of interest and to have foreground and background intentionally out of focus, in order not to distract the attention of the spectator.

If you compare Leica snapshots with those of a larger camera, you will notice at once the increased depth of focus in the Leica enlargement. I used the word *snapshots* for a special reason because as long as the big-camera owner is allowed to increase the time of exposure of his photos as much as he wants, he can also produce pictures of remarkable depth of focus. He must only close the iris diaphragm.

On the mount of a photographic lens a whole series of numbers is engraved which, upon first sight, seem to have no sensible relation to each other. But if in a competition between large and small camera the iris diaphragm is in both cases set to the same figure, for instance f:4.5, and then the two pictures are compared in regard to depth of focus you will win the race by a wide margin if you were the one who used the miniature camera. And if you had inquired from your competitor about the time of exposure of his picture, you would have found out that it was the same as that which you gave, provided you both gave the correct time.

In other words, the iris diaphragm affects not only the depth of focus but also the time of exposure. It seems important to study both functions. We begin, of course, with the effect upon the depth of focus. But even before we come to this, we must explain why the large camera, when the iris diaphragm was set to the same figure, yielded images of less depth of focus.

Depth of Focus and Relative Aperture

We resort again to experiments. We take a lens for a 5 x 7 inch camera and the Elmar 50mm lens. In both cases we set the iris to the figure f:4.5 although we do not know as yet what that means. We also need two screens, on which to project the images and a yardstick ruled in very fine units, with which we want to measure, not only the distance between screen and lens, but also the size of the images on the screens.

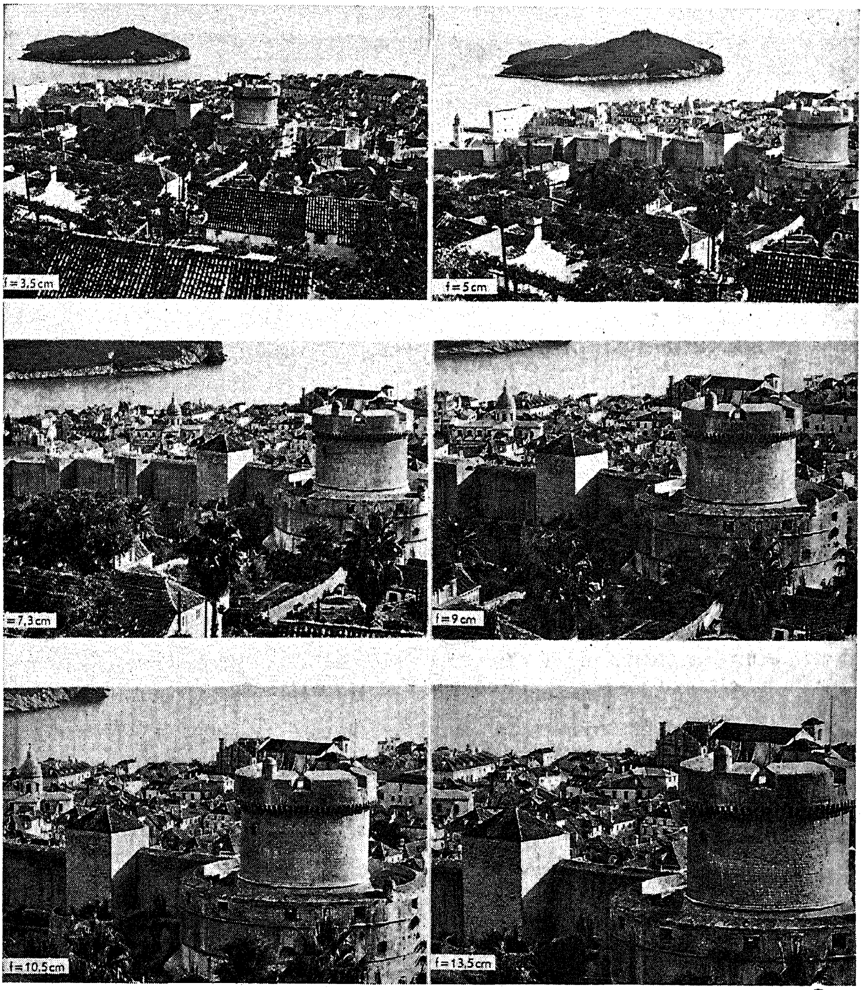


Fig. 41 Fields Covered by Six Different Leica Lenses. All Photographs Made From the Same Point

Since we want to explore various ranges of object distance, we select at first an object which is very very far away: the sun. We move the screens back and forth behind the lenses until the images are as sharp as possible. We see in both cases a very small and very brilliant spot. The screen for the large lens is about 10 inches behind the larger lens, whereas the other one is about 2 inches behind the Elmar lens.

This distance at which the image of an infinitely distant object is formed, is called *focal length of the lens.** If we have held the lenses so that their optical axes pointed directly into the sun, the images are formed in the *focal points*. The screens are in the *focal planes* of the respective lenses.

The **focal length** of a lens is a very important factor. It determines the location and size of the images which the lens forms of objects at different distances, the depth of focus, the perspective and many other things and is one of the main keys to the secret of the performance of the lens.

A comparison of the sizes of the images which in our experiment both lenses have formed of the sun reveals that, although both of them are very small, yet the one formed by the Elmar is still the smaller one.

From the experiment we learn that the image of an infinitely far object is formed in the focal plane and that the lens with the smaller focal length forms the smaller image.

Now let us select another object which is nearer, for instance a telegraph pole which is about 30 feet high and 100 feet away. We discover that the screens must be moved farther away from the lens in order to be in the plane of the image. When the screens are properly focused the one of the 10 inch lens is 0.084th of an inch (or 2.12mm) behind the focal plane. Had we left it in the focal plane, the image would have been anything but sharp. The size of the image of the pole, incidentally, is about 3 inches high.

The screen of the Elmar lens, however, had to be moved only 0.0033th of an inch (or 0.085mm). This is not much more than the thickness of a sheet of paper. Therefore it is not surprising that even as long as this screen was left in the focal plane, the image was still remarkably sharp. As to the size of the image of the pole, which the Elmar has formed, it is only 5/8th of an inch high.

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* Actually the focal length is the distance of the focal point from the so-called *principal plane*. Readers interested in optics may find further information in physics textbooks.

This experiment will convince you that the Elmar lens of the Leica camera forms images of greater depth of focus. The image of the sun (many millions of miles away) was practically in the same plane as that of the telegraph pole which was only 100 feet from the lens. But now remember figure 38 where the rays coming from one object point converge to a small spot and then diverge. As you move the screen farther away from the lens, the rays from this object point occupy a larger and larger area. At the same time the cone of rays from a nearer object point would still be in the process of converging. You must also remember that the image which a lens forms of a point even in the plane of maximum sharpness is never a true point but a small disc (circle of confusion). Thus we can illustrate the entire situation in a diagram shown in figure 42.

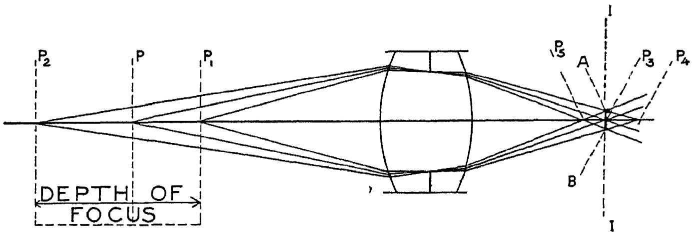


Fig. 42 Depth of Focus with Iris Diaphragm Open

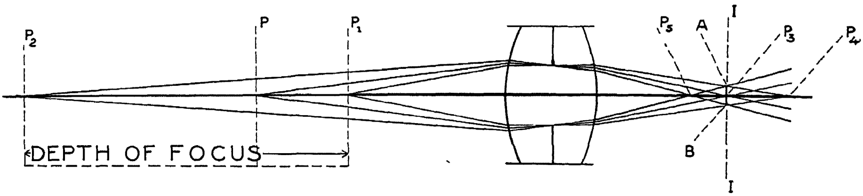


Fig. 43 Depth of Focus with Iris Diaphragm Closed

Point **P** is imaged at $\mathbf{P}_3$ where the image occupies a circle of confusion of the diameter **A—B.** Point $\mathbf{P}_1$, nearer to the lens, is imaged farther away so that in the plane **I—I** the rays are still as far apart as **A—B.** The geometrically correct plane of the image of point $\mathbf{P}_1$ is farther away, at $\mathbf{P}_4$.

On the other hand, point $\mathbf{P}_2$, farther away from the lens than **P** is imaged closer than $\mathbf{P}_3$ and in the plane **I-I** the rays have diverged so much that they occupy the area **A—B.** The total effect is that on the film held in the plane **I—I** the images of all three points are equally sharp and as sharp as the limit of resolving power of the lens.

If you have understood this relation, you will be able to answer the question: what happens when the iris diaphragm is closed further? The angular aperture of the image-forming cones of rays becomes smaller and the rays converge and diverge less rapidly. Thus the depth of focus increases. This is shown in the diagram of figure 43.

To summarize: Lenses of shorter focal length have greater depth of focus. The depth of focus of a lens of given focal length increases when you close the iris diaphragm.

Depth of Focus Scale

As mentioned before we find on the lens mount a scale with numbers, the meaning of which we have not yet explored. All we know is that these numbers refer to different apertures of the iris. But at the base of the lens mount, there is a beveled ring on which from one center index mark to both sides we find the same numbers as on the iris scale. These numbers, in connection with the distance scale on the lens ring enable you to read the depth of focus for each aperture of the iris.

You can close the iris to the mark f:4.5, focus the lens to an object which is 20 feet away and the depth-of-focus scale informs you that now even objects as close as 14½ and as far as 32 feet are in perfect focus.

If you make intelligent use of this depth-of-focus scale, you can greatly enhance the quality of your pictures. It is not always advisable to have the greatest depth of focus possible. In a portrait, for instance fine effects can be obtained by intentionally reducing the depth of focus, so that everything except the features of the subject is out of focus. Thus the attention of the spectator is at once directed to the subject of interest.

Even in other cases you can make good use of the scale. If on your honeymoon you want to take a picture of your bride at Niagara Falls you might be equally interested in showing the beauty of the falls. If you set the iris to f:9 and your bride is 15 feet from the camera which is correctly focused for this distance, everything from 9½ to 35 feet is in focus but the falls which are farther away, are not sharp. But if you consult the depth-of-focus scale you may learn that with the iris at the same stop, the same distance from the camera to the bride but the focusing mount set to a distance of 27 feet everything from 12½ feet **to infinity** is sharp. You have sacrificed the foreground for the benefit of the background. Many photographers do not realize the full significance of this possibility to correctly "place" the range of depth of focus.

At this place it is advisable to draw attention to the fact that the depth-of-focus scale should not be taken too literally. You must realize that the smaller the circle of confusion,—or to express it differently, the sharper the image or the better the correction of the lens,—the smaller is the range of depth of focus for a given aperture. The scales are mostly based on an assumed size of this circle of confusion which is still small enough to permit enlargements to about 8 x 10 inches. It was mentioned before that upon closing the iris, the actual resolving power increases. Quite a number of other factors, such as the thickness of the emulsion on the film, etc., have to be considered. Therefore, the actual range of **maximum sharpness** (especially at smaller aperture of the iris) is **not identical** with the **depth of focus** indicated on the scale although even within this latter range, the sharpness is still satisfactory.

If on the other hand your best friend wants to *get your goat* by boasting that his lens of the same focal length and the same aperture has a greater depth of focus, don't be jealous, just pity him because either he lies or he admits with his boast that his lens is not as well corrected as yours.

Thus we conclude our investigation regarding the depth of focus and direct our attention to the other function of the iris diaphragm: The regulation of the amount of light which passes through the lens.

Exposure Variations

It is quite easy to comprehend that if we close the iris diaphragm, less light passes through the lens. But this knowledge alone is of little help to us. Suppose we had to close the iris to one-half of its original aperture in order to have enough depth of focus in the picture; how much do we have to increase the exposure? Rather than try until we hit by accident the right time of exposure, let us analyse the situation. Figure 44 helps us in our investigation.

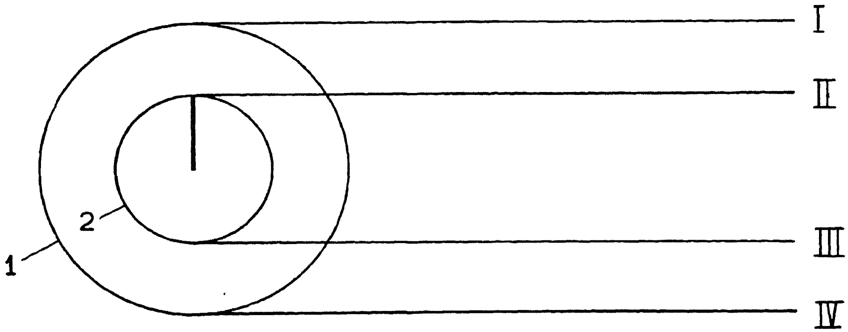


Fig. 44 Principle of "Relative Aperture"

Four rays, marked I to IV come from a distant point. If the iris diaphragm is fully open, the entire amount of light between the rays I and IV is collected by the objective. But the diagram shows only a cross section of the lens. Actually these rays would fill an area represented by the circle No. 1 at the left side of the diagram.

If we close the iris diaphragm to one-half of its original diameter only light within the cone of the rays II to III filling the area of the circle No. 2 would be able to pass through the lens. Although this circle has one-half the **diameter** of that of No. 1, you will remember that the **area** decreases with the square of this ratio. Thus only one-quarter of the original amount of light passes through the lens when the iris diaphragm is closed to one-half. Closing it further to 1/3rd of its original aperture would, of course, reduce the intensity to 1/9th, etc.

Realizing this we could make a scale which carries the number 1 when the iris is fully open, number 4 when the iris is closed one-half, number 9 when it is closed to 1/3rd, etc. These numbers would indicate the increase in exposure necessary when the iris is partly closed. But this would not fully solve our problem. Suppose you want to compare your Elmar with the lens of your old-fashioned competitor with the 5 x7 camera. His lens has a much larger diameter. Does it collect more light when the iris diaphragm is fully open? Comparative exposure data may show that even with the iris so far open that the actual diameter of the cone of light entering his lens is twice that of your lens, he requires longer exposures. What we need is an *absolute* system so that we can compare the light transmitting power of lenses of different focal lengths.

Do not forget that the lens of the 5 x 7 inch camera, having a focal length of 10 inches, also forms relatively larger images. If for instance a lens of different focal length has twice the diameter of your Elmar but objects at identical distances are imaged twice as large, the greater amount of light passing through the larger lens is also spread over a larger area (this area too increasing with the square of the size of the image) so that the actual intensity in each point of the image is the same as that in the image of your Elmar. Both lenses have the same light transmitting capacity.

In other words, the actual diameter of the lens is no useable measure for the amount of light collected by it. We must compare it with the focal length of the lens which, as you know, also determines the size of the images. The ratio: focal length divided by the effective diameter of the lens has therefore been introduced as the standard measure for the light collecting power of the lens. The increase in exposure when closing the iris diaphragm can always be found by comparing the squares of these ratios.

A practical example will illustrate how you must proceed: The lowest figure on the aperture scale of the Elmar lens is f:3.5. Since the focal length of this lens is 50mm, the actual effective diameter of the lens is 50:3.5 (or 14.3mm). How much longer do you have to make the exposure if you close the iris diaphragm to f:4.5? Divide the square of 4.5 (or 20.25) by the square of 3.5 (or 12.25) and you will find that with the smaller aperture you must expose 1.67 times as long. If in the first case (iris at f:3.5) you had to give an exposure of 1 second, you must expose 1.67 seconds with the iris at f:4.5 in order to obtain a negative of the same density.

But if you have once established the correct exposure for certain light conditions and a definite relative aperture of the lens (for in-

stance f:4.5) you can give this exposure to any photo, regardless of the focal length of the lens. The Hektor 135mm at f:4.5, the Elmar 90mm at f:4.5, the Summar 50mm at 4.5, the Elmar 35mm at f:4.5; all these lenses at these apertures require the same time of exposure. Stick to this rule, even if supersensitive experts tell you that they have discovered minute variations in densities of negatives thus taken. The latitude of the film will protect you.

Also remember that the effective diameter of a lens, even when the iris diaphragm is fully open, is not equivalent to the diameter of the first element in the lens but to the diameter of the cone of rays in an optical reference plane called **entrance pupil.** The size and shape of the first element depends entirely upon the plan of design of the lens and can vary even if the light transmitting power remains constant.

Perspective and the Various Leica Lenses

Before we discuss the merits of the various objectives for the Leica camera, a few words must be added in regard to the perspective in a photograph because the focal lengths of these lenses vary from 28mm to 200mm and sometimes you may be in doubt whether you should go close and use a short focus lens or take a lens of longer focal length and go farther away from the object until you see the same relation between image and frame size in the field of the view finder.

We have seen that the focal length of the objective determines the size of the image of any object at different distances. It is to our advantage if we become acquainted with the exact mathematical relation between the focal length, the object distance, the size of the object and that of the image. This relation can be expressed by the following equation:

$$\frac{O}{I} = \frac{D - f}{f}$$

the symbols finding their interpretations as follows:

O = size of the object
I = size of the image
D = Distance of the object from the lens
f = focal length of the lens.

This fundamental equation should remain in the memory of every photographer because he can derive great benefit from it. The left side represents the ratio of reduction in the image. Here is how you can apply it:

Suppose you have obtained permission to photograph the animals in the zoo. There is a beautiful lion which you wish to photograph. The bars of the cage are about 15 feet from where the lion generally reposes. Which objective should you take along so that you can hold the camera between the bars of the cage and snap the picture without wasting space on the negative for the empty cage?

The lion is 6 feet long (72 inches) and the longer side of the negative is 1½ inch. The ratio of reduction must be 72 : 1½ or 48 : 1. The object distance is 15 feet (180 inches). The equation tells you that the objective which you should use must have a focal length of 3.6 inches or about 90mm.

But we can gain more valuable information from this equation. You know that objects which are far away appear small and those which are close appear large in the picture. This accounts for the perspective in the picture.

The ratio at which the image size decreases with increasing object distance likewise depends upon the focal length of the lens and can easily be determined with this equation.

Suppose you want to photograph the telegraph poles along the road side. They are about 20 feet high. The first pole is about 75 feet from where you stand and the distance between each following pole is 75 feet. At first you take a photograph with the 90mm lens. The equation tells us that the image of the first pole is 24mm high, that of the second pole is only 12mm high or one half the size of the first one.

Now you change to the Elmar 50mm, but you **remain standing where you were.** On this negative the first pole appears as an image of only 13mm and the second one is about 6½mm. Although both images are smaller the second pole appears again at one-half the size of the first one. From this experiment we learn that: **lenses of different focal lengths, used for photographing from the same distance show identical perspective in the image but different ratios of reduction. The smaller the focal length the greater the ratio of reduction.**

But when you use the 50mm Elmar you can *go closer to* the first pole until its image is again 24mm high. You must now approach it until you are only 41.7 feet away. But now the image of the second pole is only 8.6mm high or only slightly more than **1/3rd of the size** of the first one. From this experiment we learn that: **lenses of different focal lengths used for photographing so that the ratio of reduction of the image of one given object remains the same, show different perspective. Lenses of shorter focal length yield images with more pronounced perspective.**

If you hold side by side the two photographs of the telegraph poles taken with the 90mm Elmar and the 50mm Elmar from different points of view so that the first pole in both cases is equally long in the pictures, you may want to know which of the two has more natural perspective. The general problem involved is somewhat complicated because various factors are involved. For instance, we must give consideration to the size of the enlargement and the distance from which we look at it. But in general we may assume that an enlargement of 5 x 7 inches is held about 10 to 12 inches from the eye and as the size of the enlargement increases we also increase the distance from which we view it.

Under these conditions **the most favorable focal length of a lens for the negative size of the Leica camera is 50mm.** A lens of this focal length will yield images of the most natural perspective. It is, therefore not surprising that this is the focal length of the most popular Leica lenses.

Only if you want to photograph from a rather close distance, as in portrait photography, it is advisable to select a lens of slightly longer focal length. As we come too close to the subject, the size of the image increases so rapidly that there is a tendency for the image of the closest features to be unproportionally larger than that of the farther features. Then you obtain pictures where the nose is large and the ears are too small. Such portraits are not flattering. Some photographers are of the erroneous opinion that for portrait photography the miniature camera is altogether unuseable. This assumption is wrong. In fact, the miniature camera can produce portraits with a perspective which is **identical** to that which we find in portraits taken with cameras of larger negative size. A lens of about 73 to 90mm will do the trick. The reader who is sufficiently interested in this problem will find a detailed investigation by the writer in the October 1934 issue of Photo Art Monthly. If we select an objective of still longer focal length, the portrait will even lack in "plasticity" and the faces will appear too flat.

We have gradually acquired knowledge about some of the most fundamental principles of photographic lenses in general and can appreciate the special requirements of lenses suitable for miniature

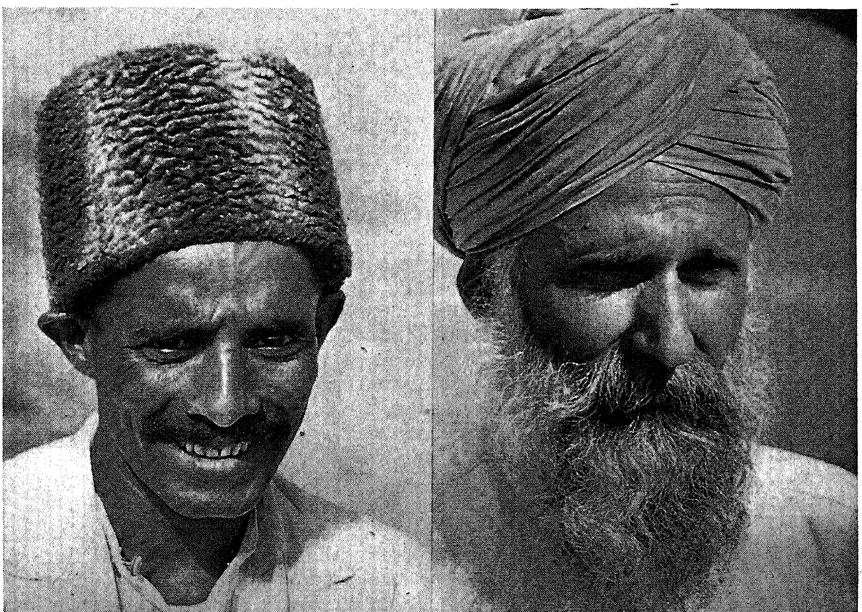
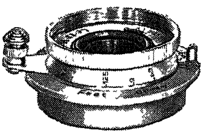
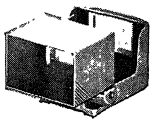


Fig. 45 Indian Guides — Felix Schoedsack
Elmar 90mm Lens, Panatomic Film

cameras. The family of Leica lenses has grown steadily and we may summarize our knowledge by discussing each of them.

The Hektor 28mm f:6.3. This lens has the shortest focal length of all available for the Leica camera; as such it yields pictures having the greatest depth of focus. Even with its diaphragm wide open at f:6.3 when fixed at infinity the range of sharpness of this lens will include everything from infinity to within as little as 12 feet from the camera. Incidentally, the short focal length of this lens accounts for the great reduction in size of the image of objects that are apparently near the camera. This power of reduction permits us to cover a much larger field and to crowd more things into a single frame of the Leica negative. The lens actually collects rays within an angle of 76° into the frame of the negative. It is distinctly a wide angle lens. The perspective which is quite accentuated offers attractive possibilities to the skillful photographer especially on account of its almost unlimited depth of focus. These two factors: rapidly receding perspective and depth of focus are very useful in the treatment of architectural subjects. The "super speed" photographer may consider this lens slow because its largest opening is only f:6.3. One should realize, however, that for a specifically wide angle lens having such extremely short focal length, yielding images so completely free from distortion—the aperture of f:6.3 may be considered an achievement of optical craftsmanship. The lens comes in a non-collapsible mount, its short focal length making it possible. A special view finder which renders a clear and brilliant image of the field is available for this lens.



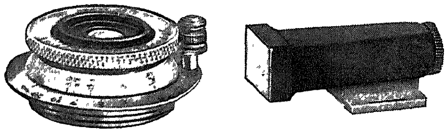


The Hektor 28mm Wide-Angle Lens with its Special Brilliant View Finder.

The Elmar 35mm f:3.5. This is another member of the wide angle lens family which covers an angle of view of 65°. While the angle of vision is somewhat smaller than that of the Hektor 28mm, this is amply compensated by greater light collecting power of its comparatively large aperture of f:3.5. Pictures made with this lens have considerable depth of focus and their perspective is more nearly approaching that of normal vision. These two features of the Elmar 35mm lens make it an ideal medium for snapshooting. Set for infinity, with its diaphragm slightly stopped down it requires almost no focusing. From the depth of focus scale we know that with the diaphragm set for f:6.3, when the lens is focused for 30 feet, the range of sharpness will extend from 10 feet to infinity. Thus focused, the camera can be kept in constant readiness in the pocket or in the Everready case. Due to its short focal length the lens does not need a collapsible mount and protrudes only slightly beyond the body of the camera, rendering it very handy for quick work. Though its field of view is adequately covered by the Vidom Universal View Finder so many people find it more convenient and expedient to use in connection with this lens the special small view finder available for it. It fits snugly into the clip of the camera upon the range finder, combining maximum convenience with minimum of bulk. For general outdoor photography the

speed of f:6.3 is quite adequate. If candid photographs have to be made in artificial light, when critical focusing may require more time than is available—the lens can be left wide open and set to an approximate focus. The aperture of f:3.5 is often sufficient to secure usable negatives even in artificial illumination if super-sensitive film is used.

Fig. 46 Elmar 35mm f:3.5 Lens with its Special View Finder which fits into the camera clip.



The 50 mm Lenses

The Elmar 50mm f:3.5. This is the lens which made the Leica camera famous. The sharpness of the pictures taken with this lens was responsible for the immense success of the Leica. It may be remembered that more than 35,000 Leica cameras were sold before a model with interchangeable lenses was offered. The Elmar 50mm is still the best standard lens upon which you can build your equipment. This lens really set a new standard for the correction of the optical equipment of cameras and carries a great share of the credit for having *put across* the idea of miniature photography. The Elmar plan of design was later on used for four other Leica lenses of 35mm, 90mm and 105 mm.

The maximum sharpness in the negative prevails when the objective is stopped down to about f:6.3 or f:9; and upon closing the iris further there is no *noticeable* decrease of sharpness in the negative.

The depth of focus of this Elmar 50mm is still remarkable and it was with this lens that the surprising possibilities of miniature cameras in combining speed of the lens, depth of focus and sharpness of the negative were first demonstrated so successfully to the public who became at once enthused about miniature photography. The perspective of its pictures is *natural.* The lens can even be used for portrait photography although in cases where extreme close-ups are taken, it should not be used, unless you make use of a simple trick. Place the subject somewhat farther away and when you make the enlargement, use only 2/3rds of the center portion of the negative.

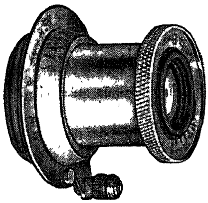


Fig. 47 Elmar 50mm f:3.5 Lens

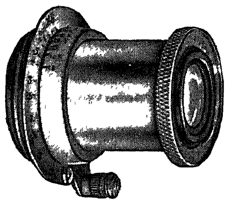


Fig. 48 Hektor 50mm f:2.5 Lens

In summarizing the merits of this Elmar 50mm one point should not be forgotten: the price question. Before the Leica appeared, an objective of an aperture of f:4.5 for a large camera was considered extremely fast, because faster lenses were hardly obtainable. Faster lenses were not made because their price would have been so prohibitive, that there would not have been any market for them. Only when the Leica with its objectives of *short focal length* made its debut, faster lenses became accessible for the amateur.

The Hektor 50mm f:2.5

This lens differs from the Elmar of the same focal length in two respects: in the first place, the name implies that it is built upon a different plan of design and secondly it has a higher speed. It was the thirst of the amateur for *still more speed* which was to be satisfied with this new type lens and this higher speed necessitated a new plan of construction. The difficulty before the lens designer was great indeed. The cry for more speed did not indicate whether the amateur knew how much more expensive a good lens of this type would have to be. The step from f:3.5 to f:2.5 means an increase of speed of 100%. You may know that if the top speed of a car would have to be doubled, it would become necessary to design a new model which may be three to four times as expensive. Such margin was not available for the lens designer. The speed increase would have to be gained by making a sacrifice in some other respect. If we follow the historical course of events we must not forget that when the Hektor 50mm was created an enlargement of 5 x 7 inches was considered rather a satisfactory size. Strange, how quickly fashions change! From the short skirt to the long skirt was hardly more than a year. From the 5 x 7 enlargement to the monstrous size of 16 x 20 from a Leica negative was only a few years!

But the Hektor 50mm with 100% increase in speed and a slight decrease in sharpness at full aperture, was so designed that even if the iris was closed only to f:4.5 or f:6.3 the sharpness equalled if not surpassed that of the pictures of the Elmar 50mm. And furthermore, this lens has one other slight advantage over the Elmar. Its plan of design made a slightly higher color correction possible. Critical and impartial amateurs may have noticed slightly superior results with the Hektor 50mm over those of an Elmar 50mm when using panchromatic films.

In spite of these advantages and a moderate price the Hektor 50mm lost some of its popularity as soon as a faster lens became available, although at a still higher price.

The Summar 50 mm F:2

This lens must be considered as a triumph of the science of optics. You will remember that the quality of a lens can be judged by finding how much the iris diaphragm can be opened with beneficial increase in sharpness of the picture. When we come to as high an aperture as f :2 we may be satisfied by seeing **how little the sharpness decreases.** The Summar 50mm at this high aperture yields images so sharp that even when enlarged to the size of 8 x 10 inches the smallest detail is still beyond the limit of resolving power of the human eye if the photo is held 10 inches from the eye.

With the iris diaphragm fully open the speed of the Summar 50mm is three times as high as that of the Elmar at its best. This speed is enough to enable the photographer to take photos even under extremely unfavorable light conditions. Thus it was with this fast lens that the Leica camera conquered another field: candid and stage photography. And as the miniature camera is used for more and more seemingly impossible tasks, these fast lenses also opened the field of snapshooting with infra-red sensitive films and filters. These invisible rays to which film emulsions can be made sensitive, are so different from the rest, that it is not surprising that they refuse to unite with the visible rays in forming an image, even if they pass through as excellently corrected a lens system as the Summar 50mm.

But the focusing scale of the Summar provides for a correction so that if you have eliminated the other rays by means of a filter, you can still obtain sharp pictures with infra-red rays. On this scale you will find two index marks, one of which is provided with a letter **R**. Suppose you have focused the camera on an object and the regular index mark points to 30 feet. Before you take the photo, simply turn the focusing mount slightly until the mark with the letter **R** points to the distance of 30 feet. Then you will obtain a sharp picture.

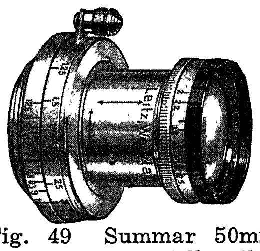
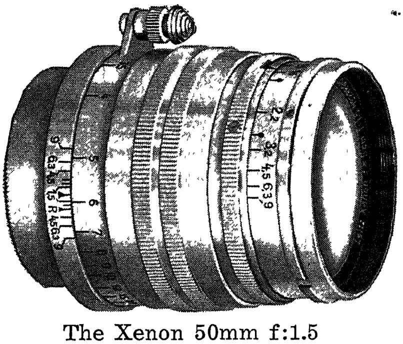


Fig. 49 Summar 50mm f:2 Lens in Collapsible Mount

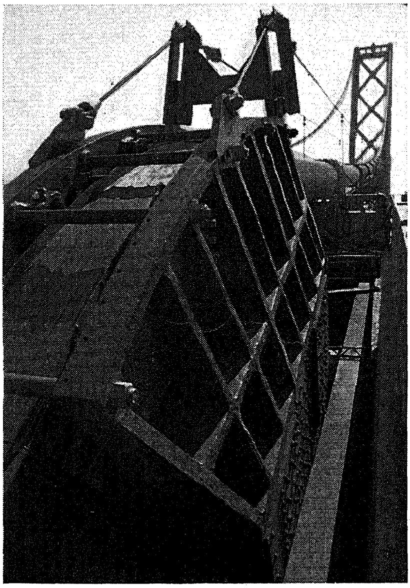


The Xenon 50mm f:1.5 Superspeed Lens.

The Xenon 50mm, f:1.5. As this edition goes to press we learn of the fulfillment of the dream of so many Leica fans. A lens of the ultra speed of f:1.5 of the standard focal length of 50mm has become available. This addition to the family of the Leica lenses is so recent that only this last minute announcement of it can be made in this edition. First photographs made with this lens reveal a remarkable over-all sharpness throughout the

entire negative area up to the very edge and corner of it. This is an outstanding accomplishment for a lens of such high light transmitting power. Two such photographs made under ordinary light conditions with the lens wide open are being offered to prove the claim. The lens is finished in beautiful and durable chromium and its mount is so designed that its rotation for critical focusing can be accomplished either by moving the regular locking thumb-knob or by grasping the outer knurled collar of its mount. Some people find that the latter method assures smoother operation. This lens should gratify the yearning for high-speed lenses of even the most radical speed fiends for some time to come.

Eddie Cantor by J. Winton Lemen
Xenon 50mm, f:1.5, 1/100 sec.



Oakland Bridge Anton F. Baumann
Hektor 28mm, f:12.5, 1/40, Panatomic.

The Hektor 73 mm F:1.9

This lens has a slightly noticeable softness at full aperture. But this trace of lack of sharpness is very much less pronounced than that in its cousin of 50mm focal length. Such improvement could be accomplished because in the plan of design of the 73mm lens it was preferred to place perfection of correction before the necessity of a low price.

The lens is perhaps the best among those offered for the Leica for the purpose of portrait photography and here this minute effect of softness is rather a benefit. In portrait photography the smaller range of depth of focus which results from the longer focal length and higher speed is also an advantage because the subject of interest can thus stand out more distinctly against the blurred background.

With the diaphragm closed to f:4.5 or more, the sharpness of the pictures obtained with the Hektor 73mm also surpasses that of the pictures taken with the Elmar 50mm, especially when panchromatic film is used.

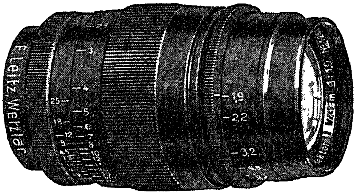


Fig. 50 Hektor 73mm f:1.9 Lens

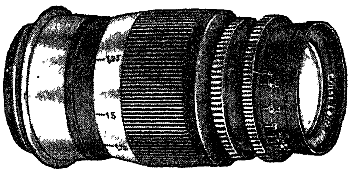


Fig. 51 Elmar 90mm f:4 Lens

The Elmar 90 mm F:4

The general characteristics of this lens need hardly be enumer ated because they are evident from the preceding general remarks. In regard to sharpness it fulfills every expectation. The depth of focus is naturally smaller than that of the Elmar 50mm. But in outdoor photography the lens will mostly be used for longer distances and then the depth of focus is sufficient for all purposes. Its speed is high considering the rather long focal length. It is also an ideal objective for portrait work.

Due to its price, which is lower than that of the Hektor 73mm, the Elmar 90mm may also deserve preferred consideration in completing a lens equipment. With three lenses, of 35mm, 50mm, and 90mm focal length, almost any task can be fulfilled.

The Thambar 90mm f:2.2

Undoubtedly this lens will contribute considerably towards a successful invasion of the field of Portrait Photography with the Leica camera and will convince those who still have serious objections to portrait photography with this small camera. Its focal length is ideal for portrait photography and its extremely high speed offers three distinct advantages. In the first

place, it permits a reduction of the depth of focus which is often necessary in portrait photography when we wish to have the subject stand out against a soft or unsharp background. Secondly, this high speed of the lens permits shorter exposures or less light, so that even under unfavorable light conditions it may be possible to take snapshots. This is an important point if we aim for natural and unposed expressions of the subject and wish to avoid the somewhat self-conscious and lifeless artificial effects which are so often found in posed portraits.

Finally, the high relative aperture and the very peculiar and entirely novel plan of design of this lens make it possible to obtain a soft focus effect which can be varied within wide limits. The means which are available for this purpose are somewhat unusual and quite ingenious. Since aside from the well known means of increasing the sharpness of soft focus lenses by closing the iris diaphragm (thus reducing the amount of spherical aberration which the marginal rays cause, and which produce the soft focus effect) there is also the possibility of eliminating the rays in the center by introducing a so-called "center spot".

Fig. 52 The Thambar 90mm f:2.2 Lens with its "Center Spot" Disc in a Screw-in Mount

This "Center Spot" is introduced over the front of the lens by means of a disc of optically flat thin glass in a screw-in mount which has a small semi-opaque spot in its center, which "closes" the center of the lens to all light. This method of obtaining a soft focus creates very pleasing effects in portrait photography as well as general photography with back light.

When this lens is "stopped down" further, the image will be really crisp and sharp so that the Thambar can also be used for regular landscape photography and other purposes. These features and the agreeable fact that the Thambar is relatively low priced (considering its very high relative aperture) make it a useful and versatile Leica lens.

The Elmar 105 mm F:6.3

In many ways similar to the 90mm lens, this Elmar may be preferred by the tourist who wishes to economize in weight of equipment and needs the longer focal length for photography at long distance. The lower speed is not directly objectionable because when you take a picture from the peak of a mountain to the next you usually have ample light at your disposal. (As this edition goes to press we learn that the production of this lens is being discontinued.)

The Hektor 135mm f:4.5

This is decidedly a lens for long distance photography. Although still useable for portrait work, the critical judge may notice a certain flatness (lack of third dimension) in portraits taken with the Hektor 135mm.

These lenses of long focal length are sometimes called *Teleobjectives.* The expression is misleading, to say the least. The term actually refers to a type of long focus objectives with a very definite plan of design, consisting of a combination of a convex lens system. As you will remember, the Hektor type has improved color correction and at apertures not exceeding f:4.5 it yields images of perfect sharpness. Those who use panchromatic or infra-red sensitive film with red or infra-red filters may find the Hektor 135mm the best lens for long distance photography.

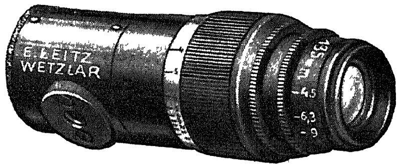


Fig. 53 Hektor 135mm f:4.5 Lens

The Telyt 200mm (8 in.) f:4.5

This new lens is a Tele-Objective in the full sense of the term (a true TELEPHOTO lens). It is so designed that the distance between the film plane and the lens is shorter than the focal length, a feature which is characteristic of the Tele System on which this lens is based. This is obtained by introducing a negative lens element back of the positive lens element. Thus, while the focal length of the Telyt is 65mm longer than that of the 135mm lens its barrel is only 3.3mm longer. It will be remembered that the Hektor 135mm lens is not built on the principle of the Tele System but is a regular anastigmat of long focus. The Telyt is the first Tele System objective in the series of Leica lenses. Its correction is excellent so that it produces images entirely free from distortion. Particular attention was given to chromatic correction which makes the lens available for long distance photography with panchromatic and Infra-Red film in connection with red and Infra-Red filters. Excellent results may be expected in this type of work. It should be remembered, however, that for long distance photography clear atmospheric conditions are quite essential. While aerial haze can be overcome with

the aid of haze-cutting filters, it is almost hopeless to attempt to photograph across so-called "heat-waves" or heat currents caused by rapidly rising layers of air heated by sunrays or by heat reflected from the ground. Such conditions cause local variations of the refracting power of the air, resulting not only in decreased sharpness of the photographic image but frequently in its complete distortion.

The long focal length of this lens made it possible (and necessary) to equip it with a special mirror reflex focusing device contained in a small and compact dice-like box which is attached directly to the camera. For this particular lens such a method of focusing was preferred to the direct coupling to the automatic range-finder. It combines the advantages of extremely accurate focusing with the convenience of viewing the entire picture on the ground glass of the mirror reflex box through a 5x or a 30x magnifier.

Best results can be obtained with the Telyt only if a good tripod is used or if the camera and lens are otherwise rigidly supported.

The Telyt, as compared with the standard 50mm lens, yields a magnification of 4x. Its view angle is approximately 12°. Its focusing mount permits direct focusing by scale from infinity to

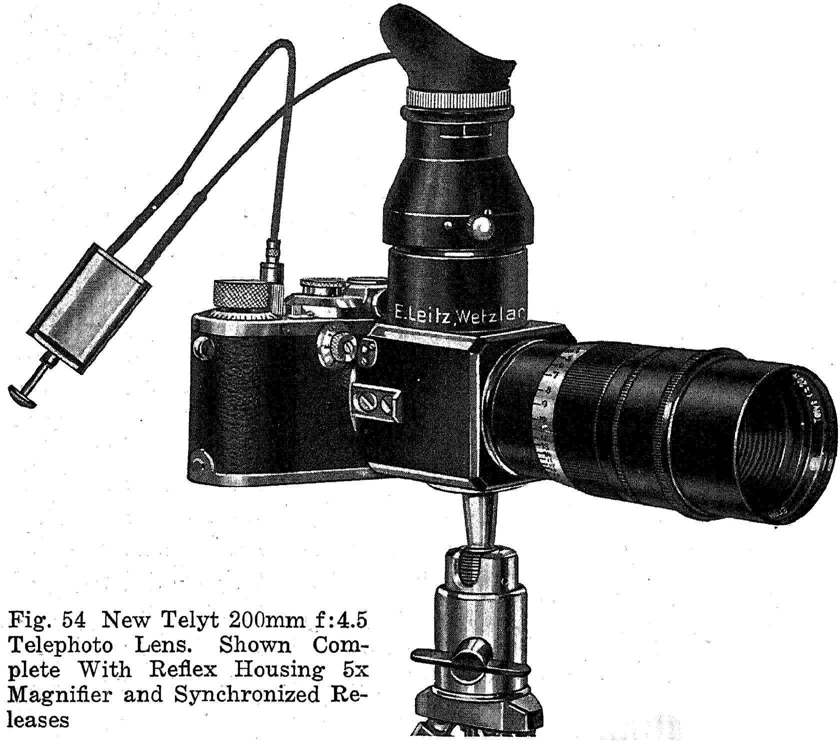


Fig. 54 New Telyt 200mm f:4.5 Telephoto Lens. Shown Complete With Reflex Housing 5x Magnifier and Synchronized Releases

Two Photographs Taken From the Same Position with the 28mm Wide Angle and the Telyt Lenses

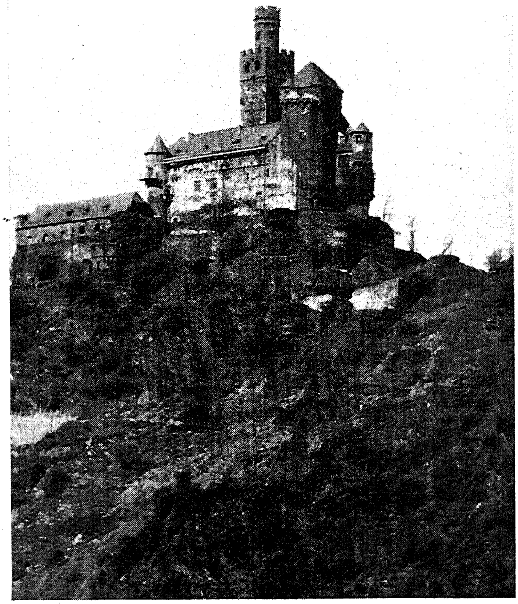


Fig. 55 Photograph Made with the 200mm Telyt Lens

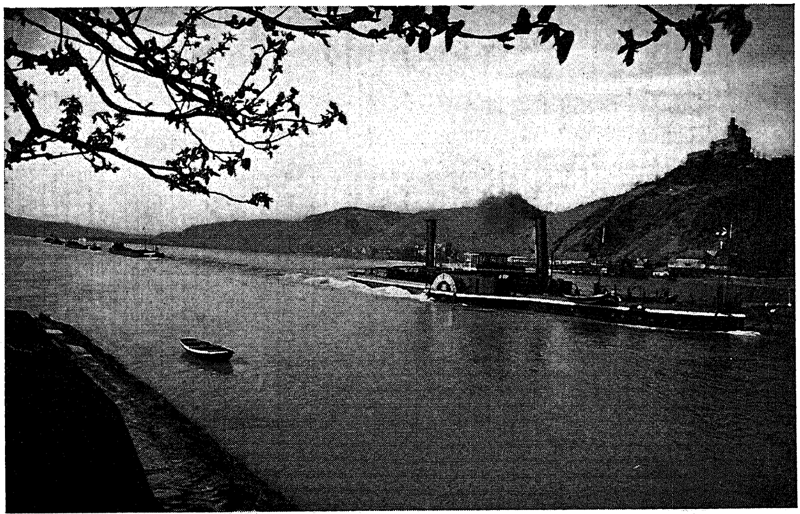


Fig. 56 General Wide Angle View Obtained with the Hektor 28mm Lens

9 feet. At 9 feet it covers an area of approximately 12 x 18 inches. Special extension tubes are available for this lens permitting close-ups down to a working distance of 4 feet from the camera, at which distance the lens will cover an area of 4 x 6 inches, yielding a magnification on the negative of approximately 4½x.

The basic principle of interchangeability of Leica lenses has been maintained in the Telyt. The mirror reflex housing can also be used with other Leica lenses, particularly with the Hektor 135mm, which can be supplied in a special shortened mount (without the automatic coupling), which is simply screwed into the reflex housing in place of the Telyt. When thus used the lens is acting as a normal 135mm objective and can be used up to infinity.

Using the Mirror Reflex with Other Leica Lenses

Other Leica lenses of shorter focal lengths are limited to close-ups when used in connection with the reflex housing. If the focusing mount of the respective lenses is set for infinity the resulting ratio of reduction or magnification respectively (on the film) is as follows:

Lens:	Focal Length	Ratio of reduction (on film) (*lens set for infinity*)
Hektor	135mm	1:2.2
Elmar	105mm	1:1.7
Elmar, Thambar	90mm	1:1.5
Hektor	73mm	1:1.2
		Ratio of magnification (on film) (*lens set for infinity*)
Elmar, Hektor, Summar, Xenon	50mm	1.2:1
Elmar	35mm	1.8:1
Hektor	28mm	2.2:1

For estimating correct exposure with these lenses, whose focal lengths are reduced by their use in connection with the reflex housing, formulas offered in the chapter on copying and close-up photography should be consulted. The length of the reflex housing (considered as an extension tube) is 62mm.

Front Lenses and Close Distance Photography

The problem of photographing objects at close range can be solved in two different ways: either we can introduce intermediate extension tubes to increase the distance from the lens to the plane of the negative, or we can reduce the focal length of the lens system by placing front lenses before the regular objective.

The use of extension tubes directly on the camera together with table of working distances, ratio of magnification etc. will be found on page 195.

As we see from the Front Lens tables, these auxiliary optical systems permit the photographing of objects with the Leica camera from 3½ feet to 10 11/16 inches from the camera back. The smallest object which can thus be photographed to fill the negative frame measures 3⅜x5 inches. If we wish to compare the optical principle of photography with Front Lenses and with intermediate rings, we must again recall a few optical principles. It will be evident that if in figure 58 the object point would have been infinitely far away, a practically parallel bundle of rays would have entered the lens. We have neglected so far to mention that if the lens is so designed that it will converge with the highest perfection any *parallel* bundle of rays, it is by no means to be understood that this same lens system will converge with the same perfection (although in another plane) a *divergent* bundle of rays from an object point which is nearer to the lens. In other words, a lens which will yield the sharpest image without spherical aberration when the object is far away will not yield as crisp an image when the object is close to the lens. As the object moves from infinity to minimum distance of 3½ feet the amount of divergence of the bundles of rays entering the lens is quite negligible, but if the object comes considerably closer the spherical aberration would become so noticeable that the images would suffer considerably in quality.

If we add a Front Lens to the Leica objective, we reduce the focal length of the entire lens system in a peculiar way and we learn from the tables that for instance through the addition of Front Lens No. 1 to the Elmar 50mm we can set the focusing mount to infinity when the object is only 39½ inches away. The Front Lens converts the slightly divergent rays into a parallel bundle so that through this addition the Elmar, in order to photograph an object at 39½ inches, yields an image of the same quality as one photographed at infinity without the Front Lens. This same principle is consistently applied so that with the Leica focused to 3½ feet, we can photograph objects at an actual distance of 22 9/16 inches when we add Front Lens No. 1. The front lens tables give further details.

What we have to cope with particularly when photographing at short distance is the misbehavior of light which is called "spherical aberration". We will recall that the marginal rays have a tendency to converge closer to the lens than the rays passing through the center of the objective. The marginal rays can always be eliminated by closing the iris diaphragm. Since in close-up photography, every optimum of detail rendition is absolutely essential, we cannot afford to leave the diaphragm wide open but have to close it to such an extent that through compromise of the small remaining defects in a lens system which have been described before, the

actual sharpness of the image is most favorable. The front lens tables contain definite information how much the Leica lenses have to be stopped down for the Front Lenses and various distances.

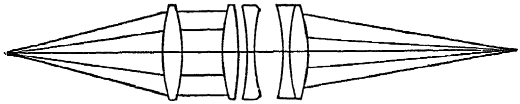


Fig. 58 Path of Rays in the Elmar Lens with Supplementary Front Lens

Another interesting fact relates to the f values of the regular Leica lenses. As long as we use Front Lenses for close-up photography, original f values retain their value because the actual light intensity gathered by the objective and expressed by the so-called f value is represented by the figure: distance from lens to image divided by the diameter of the lens. Since the use of a front lens enables us to use the same focusing mount at close distance we find that for photography of an object at 39½ inches with front lens No. 1 the distance from the lens to the film is the same as if we would photograph an object at infinity without the front lens. It is therefore possible to measure the actual intensity of the object with a standard exposure meter and compute the value for the respective aperture of the lens at which we take the photograph.

These hints may be valuable for those who use the Front Lenses and it may be added that these auxiliary optical devices are particularly advantageous if we wish to obtain the crispest sharpness and best detail rendition in flat objects within the range of distances indicated in the Front Lens tables. The question of photography at still closer distances is covered in Chapters 9, 17, 18, 20, and 21.

Proper Care of Lenses

It seems advisable to conclude with some suggestions relative to the care of the miniature camera lenses. All lenses are made with an accuracy which can hardly be found in any other piece of manufactured goods. The lens surfaces must be so smooth and so accurately spherical that even a deviation of 1/100,000th of an inch would affect their performance. It is quite evident that such a delicate and accurate piece of equipment requires special care and can easily be ruined by careless handling.

The first rule for the care of lenses is therefore: keep the lens surfaces free from dust and other impurities. When the lens is attached to the camera and not in use, see to it that it is covered with the lens cap. When the objective is removed from the camera, use the dust cap to close the other side so that the lens surfaces are not exposed and no dust can collect on them.

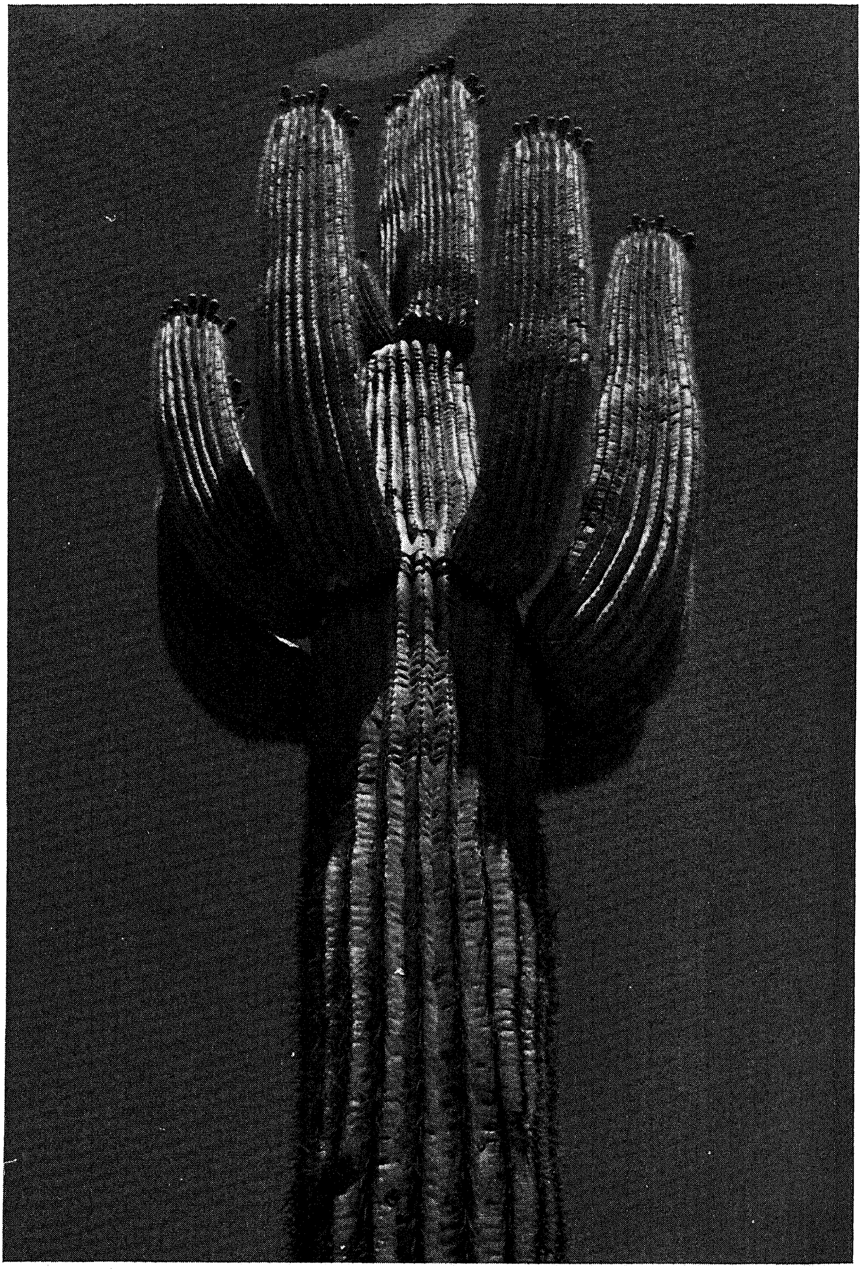
Should the surfaces show deposits of dust or other impurities, do not try to remove it by rubbing the surface with your fingers. You may wipe the surfaces with a piece of silk cloth or with a piece of lens paper. You can also use a fine camel-hair brush. In any case it is imperative that the surface be wiped very gently. The dust in the air is full of little abrasive particles which could scratch the surface of the lens. The smallest scratch is in comparison to the length of a light wave like a deep and wide trench since a light wave is as small as 1/50,000th inch. You may secure a small bottle of xylol and a package of lens paper and always moisten the paper in the xylol when cleaning the lens surfaces. In wiping the lens, have the paper make a circular motion.

If a lens surface is once scratched, it is not possible to simply repolish this surface because such action would make the entire lens thinner and would affect the optical performance. Only a replacement of this lens can fully repair the damage.

Under no circumstances should the photographer try to take the lens apart. Such warning may seem unnecessary to many miniature camera owners, yet it is given in view of experiences which have repeated themselves only too frequently. A photographer may try to insert a color filter between the lens elements, may try to clean the inside surface or find another excuse for satisfying his curiosity and take the lens apart. He will be sadly disappointed when he finds out how hard it is to reassemble the lens so that no dust remains inside. The lenses are assembled by the manufacturer in rooms which are absolutely free from dust and special instruments are used to keep dust from the insides of the lens.

Sometimes lenses show a few very minute bubbles in the glass. These are not objectionable. The area of one bubble in comparison to that of the entire lens surface, is very small and whatever small amount of light is thrown off its course by this bubble is by far too minute to cause any photographically recordable light impression. A long scratch over the lens surface is much more serious.

Altogether the photographer in trying to repair a lens should restrict his activity to a minimum. As long as the objective is kept closed by lens and dust cap no danger of serious trouble will ever arise. If something irregular comes into evidence, the objective should rather be sent to the manufacturer.



Sahuaro James M. Leonard

Elmar 35mm, 1/100th second at f:12.5, No. 1 Filter, Du Pont Superior Film

COLOR FILTERS

HENRY M. LESTER
KARL A. BARLEBEN, Jr.

CHAPTER 3

A filter is a medium which allows light rays of a certain kind to pass through, while it is more or less impervious to others. From its very definition, it appears that its function is purely subtractive: it adds nothing in the way of illumination; it merely eliminates from light certain qualities which may be undesirable. This is the reason for the increase of exposure generally required when filters are used. Thus a filter should be looked upon as just another means of controlling light and illumination in addition to the others at our disposal. These are the shutter—for control of length of time during which the light is permitted to reach the film; the lens diaphragm—for control of quantity and optical quality; the filter—for control of color quality or intensity. Additional means of light control are available in the form of reflectors and diffusers.

Photographic color filters are usually made of glass. The coloring which renders it capable of absorbing certain colors of light, while allowing others to pass freely, is imparted to it by several methods. Certain dyes are mixed with the glass in its molten state, thus rendering it colored before polishing and shaping. This provides the most satisfactory type of filter for use directly on the camera lens, it being thin, uniform, color-stable, and unaffected by changes of temperature and climatic conditions. Only breakage or scratches on the surface will impair its usefulness.

Color filters are also prepared by coating gelatin containing a given quantity of an organic dye upon optically flat and otherwise prepared glass, and after drying, stripping this film from the glass. The film is then cut to any size or shape and mounted between two pieces of optically flat glass by means of a special cement (Canada balsam) under heat and pressure. This type of filter requires greater care in handling than the solid glass type. Improper handling, contact with water, alcohol or high temperatures will render it useless. Humidity or exposure to direct action of sunlight also causes deteriora-

tion. This type of filter should never be selected for use in the tropics or for sea travel. However, for use in a temperate climate, with careful handling, it will prove entirely satisfactory. Gelatin filters are available in a far greater number of colors than solid glass filters, and being less expensive, are to be recommended for special purposes and experimental work.

Still another type of filter is obtainable in the form of a so-called water cell, which consists of a glass container having two parallel sides filled with distilled water into which the dye required is dissolved. This type of filter is used especially in scientific work, such as photomicrography, where it acts not only as a color filter, but also as a heat absorption filter. It is placed, not between the lens and the photographed subject, but between the latter and the light source.

For the purpose of general Leica photography, we are concerned only with the first two types of filters, either of which may readily be slipped on and off the lens of the camera. Of these two, the solid glass type filter is much the better for the Leica camera on account of portability. Gelatin filters have a definite place in the kit of the experimentally-minded worker, or one whose specialized work calls for an endless variety of filters for tests and for other specific purposes.

Solid glass filters are to be preferred not only because of greater stability and permanence, but also because of simplicity. Any medium transmitting light affects its course to a greater or lesser degree, depending upon whether it is optically flat. If it is, the disturbance is negligible. The greater the number of media the light has to traverse, the greater the disturbance of its course. Thus, when light penetrates thin solid glass, it is affected only by the process of entering it on one side, traversing its dyed mass and emerging on the other side. Pure gelatin filters used without mounting between glass would be just as effective were it possible to handle them in such form. But a gelatin filter, cemented between two pieces of glass, requires the light to pass through glass, Canada balsam, gelatin, Canada balsam and glass again. Obviously it is simpler to produce a filter with two plano-parallel (optically flat) surfaces than one possessing ten surfaces meeting this requirement. Of course, this is merely a theoretical, rather than a practical, objection, but it is frequently confirmed in practice resulting in pictures of lesser sharpness and poorer definition.

As a matter of fact, it should be known that filters actually affect the sharpness of the picture, the type of the filter merely accounting

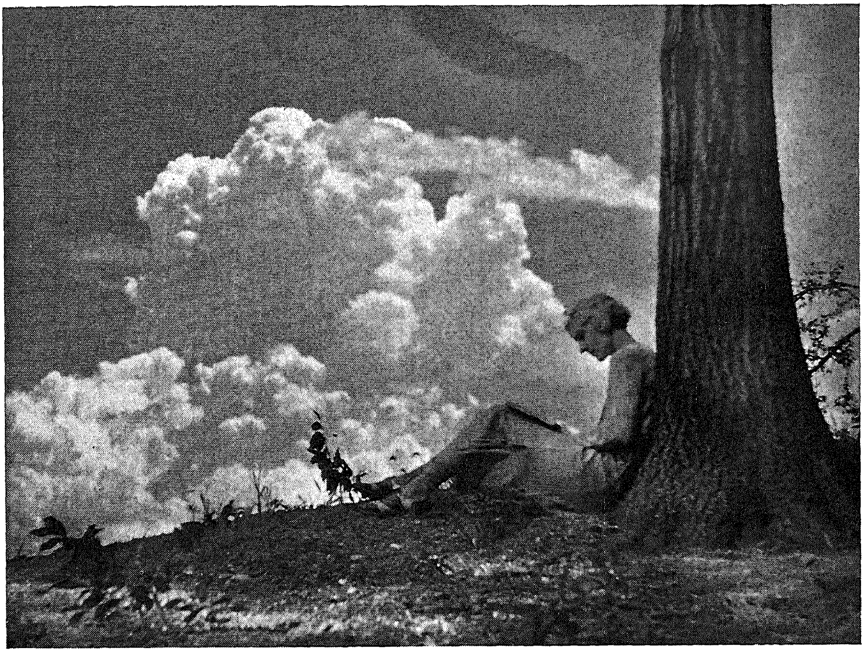


Fig. 61 Summer Solitude John L. Davenport
Elmar 50mm, 1/100 second at f:4.5. Filter: 23A, Du Pont Superior Film

for the degree of unsharpness. Theoretically speaking, the shorter the wave-length of light, the sharper the image. Violet and blue light, having the shorter wavelengths, are capable of producing sharper images. If a dense filter is used which holds back the entire amount of blue light, it permits only that light which has the longer wave length to reach the film, with the resulting decrease in sharpness of the image. Moreover, some lenses are not so well corrected for light of the longer wave length so that they cannot yield relatively as sharp an image as that obtainable in the presence of blue rays. In other words, the use of filters results in pictures of lesser sharpness because the very element which contributes most to sharp images has been eliminated or weakened.

What has been said about filters and their effect upon sharpness of images should not be taken too literally. For practical purposes, the effect of a good filter upon the sharpness of the image is, as a matter of fact, quite negligible. Most of the objections are of a theoretical nature based upon careful and painstaking comparisons made under the microscope. The purpose of these objections is not so much to discourage the use of filters as to produce a more in-

their products which gradually make the use of filters less essential.

When Filters Should Be Used

Filters can and should be used if their choice and application are made judiciously and not indiscriminately. They are intended to establish and correct contrasts between various degrees of *brightness* in the picture. The human eye has the ability to distinguish, not only between light and dark, but also between colors. Colors produce the sensation of various degrees of brightness. Since color cannot be rendered through black and white photography, we make it reproduce our sensations of the varying degrees of brightness in terms of black, white and intermediate shades of gray. To compensate for the inability of the film to interpret things in terms of telligent and judicious attitude towards their application in Leica photography. Our nearest photographic relatives, the cameramen of Hollywood, using almost the same negative material, employ filters extensively. But their results tend only to confirm what has been said: their knowledge of emulsions, plus their knowledge of filters, yield results of rare excellence and quality.

It may not be amiss to qualify filters as the "necessary evil" of miniature photography. They are something to be used if absolutely necessary, but it would be better, whenever possible, to do without them.

Undoubtedly, this very feeling prevailing among photographers causes manufacturers of film to strive for those characteristics in degrees of brightness as does the eye, we use filters. It is important to realize that ordinarily we would need no filters if the film reproduced colors at the same scale of tonal values as the eye sees them. This is important because film manufacturers strive to approach this *millenium,* and modern film materials require the use of filters to a much lesser degree than the older types of film.

Basically, color filters, as used in photography, can serve a twofold purpose: to establish the balance of color values, or to upset that balance. When the contrast between the various degrees of brightness in the pictures approximates that perceived by the eye—the balance is considered established. Depending upon the emulsion used, it is then **normal** or **corrected.** When the contrast between the various degrees of brightness is rendered differently from the visual perception—it is said that the color values, interpreted in terms of shades of gray, are **undercorrected** or **overcorrected.** A black sky or a dark gray sky with white clouds in a midsummer landscape is an example of overcorrection, while a white sky with

light gray clouds in a similar picture would indicate undercorrection. An intentional upsetting of the balance of color values may lead to attractive effects. But the practice should not become a mania.

To be able to use filters correctly, to make them fill a definite need and perform a definite task, the photographer must know the film he uses, know its sensitivity to colors, know which colors react more strongly on its emulsion and which should be suppressed and retarded so that other colors may become equally effective. This, in effect, is nothing less than handicapping one or more of the more actinically active colors in favor of those which are "slow in getting there." Thus, if the film records blue too freely, some of it should be held back. A yellow filter is used for this purpose.

A panchromatic film is, generally speaking, more evenly balanced in its response to colors, but its sensitivity to green is slightly lower than to other colors. To effect balance, all other colors must be suppressed or retarded slightly in order to give the green color an opportunity to impress itself on the film. A certain greenish colored filter is used for this.

The effect which filters have upon certain emulsions may be clearly understood from the diagrams shown. These are not accurate, but they tend to interpret the color sensitivity of different emulsions when a filter is placed in front of a lens.

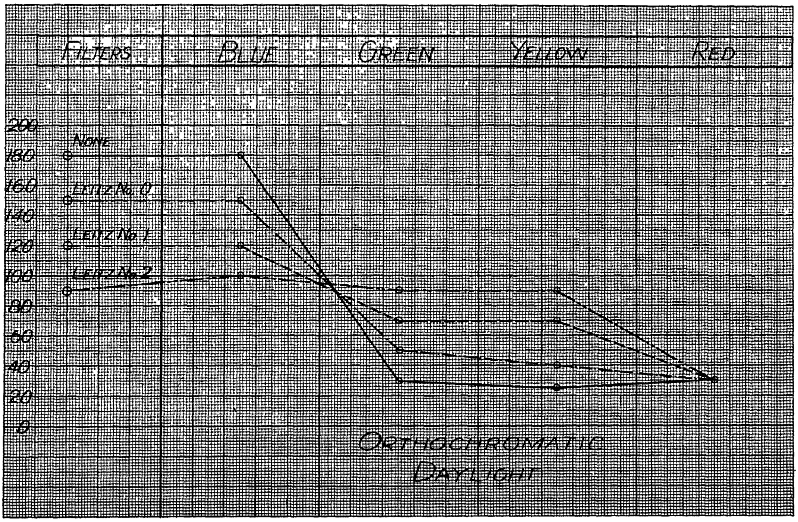


Fig. 62 Effect of Filters upon Relative Color Sensitivity of Film: A Typical Orthochromatic Emulsion (in Daylight)

In considering the use of filters, it is most important to realize that even films of the same type but of various makes have different characteristics regarding their degree of sensitivity to different colors. Thus, an **orthochromatic** film of one make will respond to certain colors to a different degree than an orthochromatic film of another make. The same applies to various makes of panchromatic films.

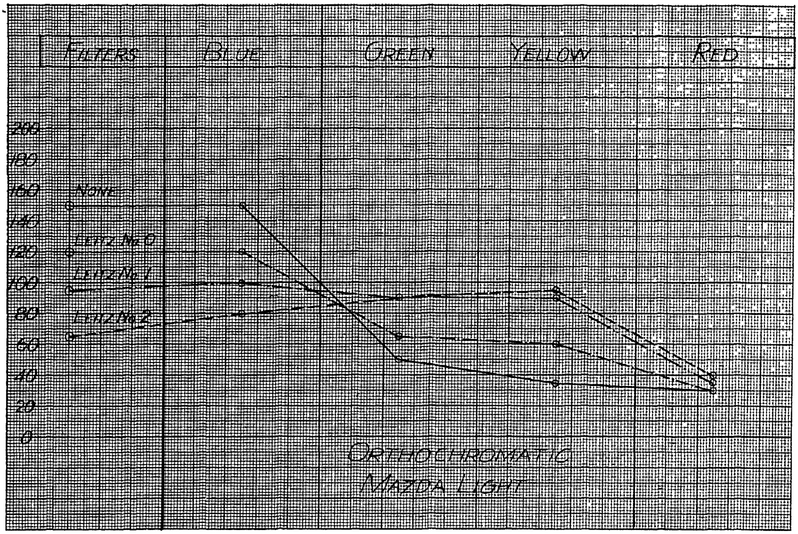


Fig. 63 Effect of Filters upon Relative Color Sensitivity of Film: A Typical Orthochromatic Emulsion (in Mazda Light)

Nearly every film manufacturer publishes spectrographs of his respective emulsions, which, if properly read, indicate their relative sensitivity to color. Some manufacturers have this information available in the form of numerical tables showing the relative sensitivity in terms of per cent, 100 standing for "normal" color rendering.

The Agfa Ansco Company offers the following information concerning color sensitivity as measured by the Agfa Step Color Chart for the same emulsion:

	Red	Yellow	Green	Blue
In daylight	**60**	**50**	**30**	**140**
In Mazda light.......	**180**	**80**	**40**	**80**

On the other hand, manufacturers of filters supply spectrophotometric absorption curves of filters which show graphically colors which are transmitted and absorbed by a given filter. A combined study of these data will yield accurate information as to what results may be expected from the use of certain filters in connection with certain films. This information, however, is not essential for the use of filters except in work of a very exacting nature. For general use, working familiarity with a film and filter may be gained by more practical methods.

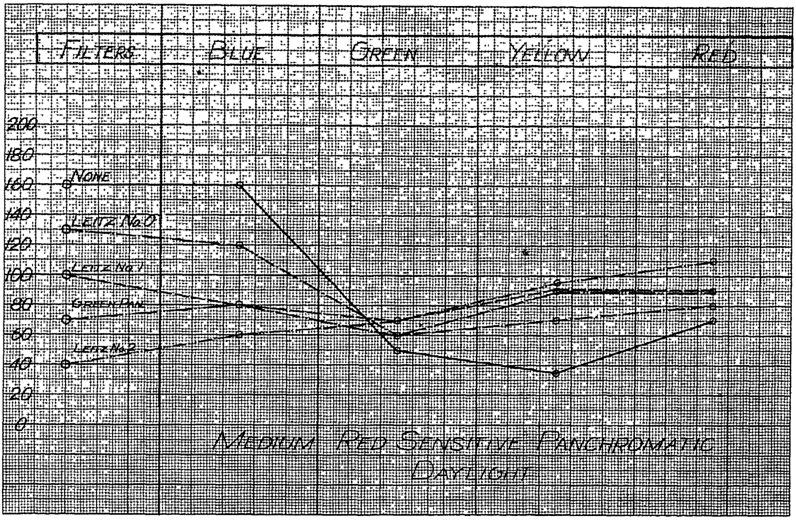


Fig. 64 Effect of Filters upon Relative Color Sensitivity of Film: Typical Panchromatic Emulsion of Medium Sensitivity to Red (in Daylight)

Making Your Own Filter Tests

If a working knowledge of the properties of a film or filter is desired, a series of exposures on the film with and without the filter is the best means of getting it. Such exposures should be made with great care and

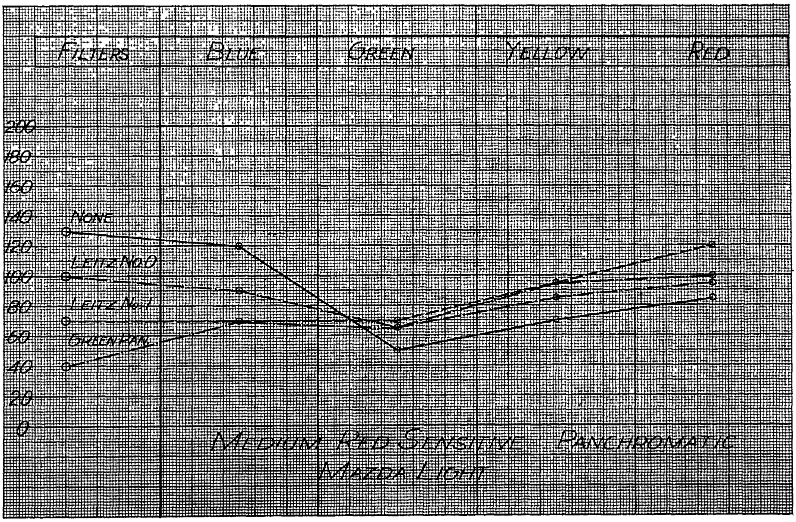


Fig. 65 Typical Panchromatic Emulsion of Medium Sensitivity to Red (in Mazda Light)

a record of conditions kept. The first exposure should be made without the filter and should be based upon a careful reading of a reliable exposure meter. The series of exposures should be carried out according to a definite plan:

Film: ....**Rated Speed:** ....

Subject: ....

Exp. No.	Light	Filter	Meter Reading	Lens Aperture	Shutter Speed
1	Daylight	None	1 sec.	f/6.3	1 second
2	"	"		"	2 seconds
3	"	"		"	4 seconds
4 Blank Exposure					
5	"	"		"	½ second
6	"	"		"	¼ second
7 Blank Exposure					
8	"	No. 2	1 sec.	"	2 seconds
9	"	"		"	4 seconds
10	"	"		"	8 seconds
11 Blank Exposure					
12	"	"		"	1 second
13	"	"		"	½ second

Similar procedure may be employed for testing one or two other filters. The exposed film should be developed in the developer customarily used. The final proof of the test is in the finished print. The best print obtainable should be made from the negative resulting from Exposure No. 1. Prints from all other negatives should be made in exactly the same way, the same paper used, the same degree of enlargement, the same exposure given, the same developer and time of development. When these prints are finished and dry, they should be compared and studied for color correction, contrasts and detail rendering.

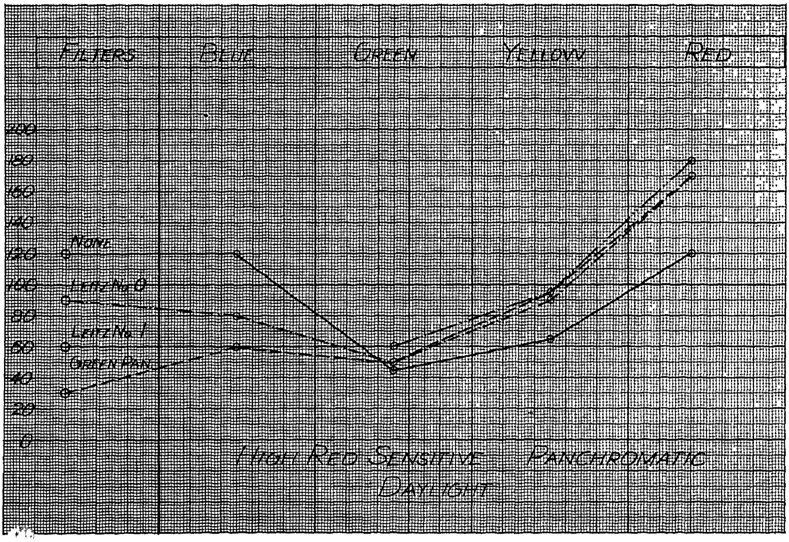


Fig. 66 Effect of Filters upon Relative Color Sensitivity of Film: A Typical Panchromatic Emulsion of High Sensitivity to Red (in Daylight).

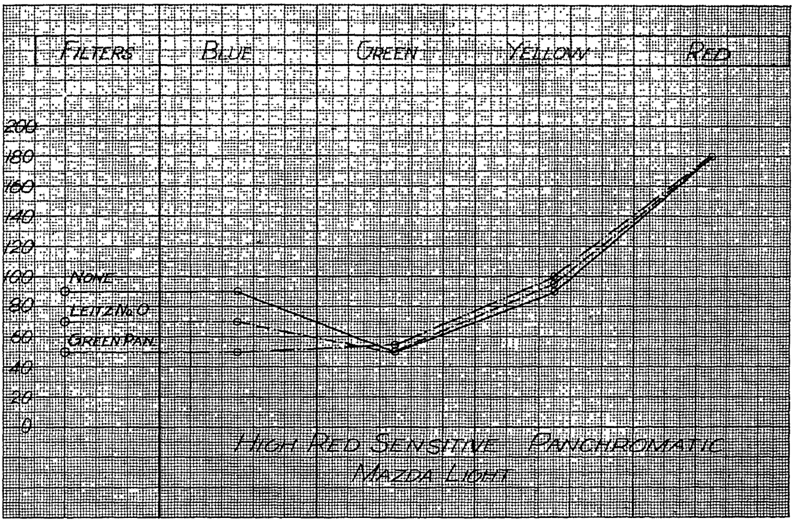


Fig. 67 Effect of Filters upon Relative Color Sensitivity of Film: A Typical Panchromatic Emulsion of High Sensitivity to Red (in Mazda Light)

Such study will frequently yield surprising results. It may be found, for instance, that best results may be obtained without the filter. Or that the most desirable effect was produced when the filter was used without increase of exposure. And then again, it may be that the picture was most interesting when no filter was used, but the exposure halved.

Thus, for instance, it will be found by actual experience that if a filter, primarily intended to suppress blue rays for which a given film is too sensitive, is being used effectively in daylight, the same filter will be found unnecessary for work in artificial light because of its more abundant yellow and red rays. Obviously, there is no need to filter blue rays from a light which is in itself deficient in that color. The same would hold true of work in the late afternoon when daylight becomes more profuse in yellow light. There would, ordinarily, be no need for a yellow filter. It must be remembered, however, that although a filter is used to establish a definite **balance** of color rendering, the use of the filter is superfluous where that balance is present either in the light source or the subject. Thus, if the sky is dark blue, even a light yellow filter will create a correct color balance on a panchromatic film, and if it be a panchromatic emulsion of **high red sensitivity,** no filter will be required to produce such balance. If the sky, however, be pale blue or grayish blue, a more dense filter would be required.

Filter Factors

To identify filters by means of their respective factors would be meaningless, since no filter requires the same increase of exposure for every film and for every light condition. For this reason, modern filters are no longer designated by the symbol "x" following a number, like 2x, 3x, 4x, etc. These designations were intended to represent the increase of exposure by two times, three and four times, respectively. Modern filters are designated by their manufacturers either by a letter, number

or both, and each represents a medium of definitely known power of absorption or transmission of certain rays of light. Consequently, filter factor tables should not be taken too literally, for the best of them are merely intended to give their relative power of absorption or transmission regarding a definite emulsion. These tables should be used as guides only. A definite familiarity with the properties of a film can be gained only through practical application very much in the same measure as is the case with emulsions, developers, papers, lenses, etc.

While color filters properly used offer a very flexible and definite control of contrasts and tones, it should be realized that there are other means with which certain effects may be produced. The making of prints by enlarging rather than by contact offers an opportunity for holding back the light from certain areas of the print while permitting it to print through on other areas. This *dodging* or *shading* by means of a moving hand, finger, piece of black paper, or cardboard enables the skilled worker to produce quite remarkable effects on the finished print. Thus, for instance, if one has a negative of a landscape on which a filter has not been used, a negative possessing all detail and gradation in the foreground but a corresponding overexposure and whiteness of the sky, the latter may be successfully *printed in* or darkened to any degree desired by first exposing the paper for a length of time sufficient to bring out the detail of the foreground and then interposing a piece of cardboard between the lens of the enlarger and the portion of the paper containing foreground, letting the sky print through. The exact technique of *dodging* and *shading* is described elsewhere. This point is mentioned here to assist any who may have neglected to use a filter and who wish to improve a picture which would otherwise appear *bare* and uninteresting from lack of an appropriate sky background.

Choice of Film and Filter

Those who lack experience in selecting a film and a filter to go with it to produce certain effects will be well served with **Viewing Filters.** These are strictly, as their name implies, visual filters and should never be used for actual photography. They consist of discs or squares of colored glass or gelatin mounted between glass. Colors, when viewed through them, are considerably dulled and impress the eye in terms of their relative brightness and contrast of tone, approximating the interpretation of the film. These visual filters are available in the form of *monocles*, or regular spectacles. By looking through them, the photographer is in a position to anticipate the effect upon the film before exposure. For work on orthochromatic emulsions deep blue filters are used, while panchromatic emulsions require either a muddy yellow or greenish visual filter. By far the most practical and economical visual filter guide for the purpose can be had in the form of an inexpensive Filter Test Chart, furnished by the Eastman Kodak Company. This chart contains eight transparent samples of the most popular contrast filters and four test filters (blue, green, yellow and red) through which subjects may be viewed.

If the subject, as seen through the monochromatic filter, appears to the eye so that one can distinguish the different degrees of brightness of the various colors, the film and filter indicated under that viewing filter should be used to secure such rendering. If one cannot distinguish the various colors, the subject should be viewed through another filter, and so on. One of these will be found to give the desired color correction. Considerable knowledge of rendering color contrasts may be gained from frequent application of this simple device.

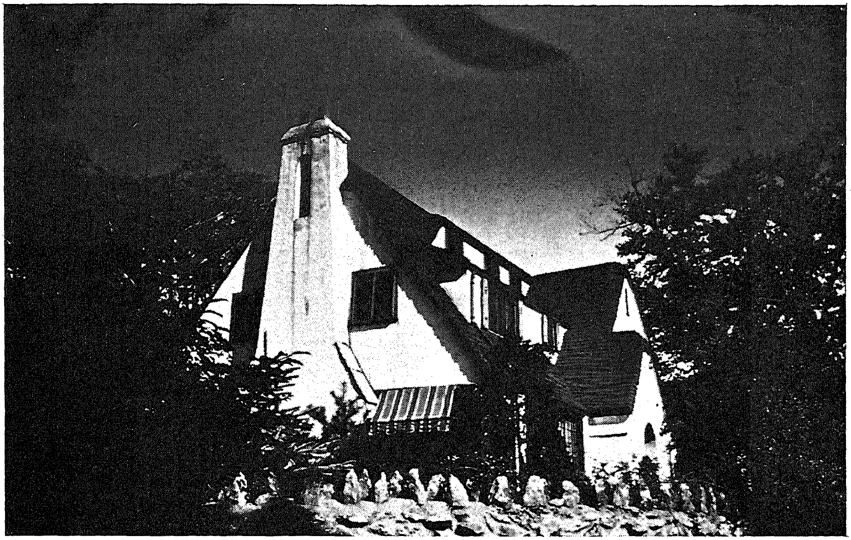


Fig. 68 Suburban Home Henry M. Lester
Elmar 35mm, 1/60 second at f:9. Sky Filter. Du Pont Superior Film

What Filters to Use

It is a good policy to follow the suggestions of manufacturers of photographic equipment as to the type of accessories. They can very well bear the responsibility for such use as it is to their interest to help obtain the best results possible. Choice of the type and make of filters used should be based upon the negative material employed. If a variety of films is used, one will be best served by the comprehensive line of solid glass filters offered by the makers of the Leica camera. These filters are of excellent quality, thin, uniform and well mounted. The filter mounts are important, particularly when the camera is to be used in connection with the various accessories and attachments for which these mounts are designed. For special purposes, and for specific work with Eastman Kodak emulsions, the Wratten Light Filters (gelatin mounted between glass) should be used, they being also of excellent quality and easily available in unmounted circles fitting the Leica Filter mounts. The Wratten Light Filters are especially designed for Eastman emulsions and the most comprehensive information is available on their effect on these emulsions.

One would be well served with a complete line of Leica filters to which special Wratten Light Filters may be added as required. However, an impressive array of filters is not needed to turn out excellent pictures. One or two should be sufficient for all general work with modern film emulsions. The writers know of several workers who boast of many an excellent picture but of only one filter.

Those who prefer orthochromatic films will be able to go through life with but one or two filters without missing anything. Leitz No. 1 would be the best choice, while No. 2 might be added to complete the outfit. The addition of a Graduated Sky Filter might be included sometimes in preference to the No. 1. The equivalent of these are the Wratten K1 and Wratten K2.

Users of Panchromatic Films may use more filters, but only if the scope of their work is greater. Besides the two filters mentioned above, together with possibly the Sky Filter, the Green Panchromatic Filter should be used. If Eastman panchromatic emulsions are employed, instead of the Leitz Panchromatic Filter, the Wratten XI (for day light) or the Wratten X2 (for artificial light) should be used.

The Leitz Infra Red Filter is a special filter which should be used in connection with the Infra Red films for special effects. It is one

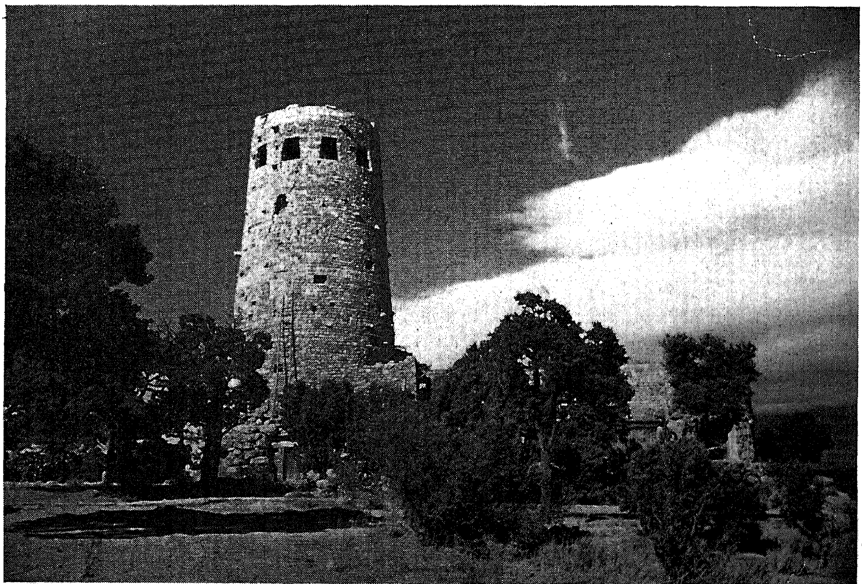


Fig. 69 The Tower — Ernst Schwarz
Elmar 35mm lens, f:9, 1/60, dark yellow filter, Agfa Superpan.

of those filters which for special reasons emphatically upsets the color balance. The Wratten line offers a complete assortment of red filters, ranging from very pale red to such densities as do not transmit visible light. The choice of the density should be governed by the purpose for which it is intended.

A special filter is made by the Leitz Company for elimination of invisible ultra violet rays adjoining the visible range of the spectrum. These filters are intended for use only in high altitudes where these rays are abundant. At sea-level invisible ultra violet rays are not sufficient to be detrimental. In small amounts they are not effective, being actually filtered out by the glass of the lens itself. Never use a filter unless one is required to eliminate something that is not wanted in the pictures. With particular reference to the Ultra Violet Filter, commonly known as the U. V. Filter, it should be remembered that if the filter holds back only certain rays, the effect of which we want to suppress in the pictures, whereas it freely transmits all other rays, the exposure need not be increased to compensate for that filter, since those colors that will result in underexposure are being deliberately so treated by the very use of the filter. The same may apply to some other filters, particularly those pale yellow, pale green and pale blue filters which are used for very slight color correction. While actually even clear glass filters require a theoretical increase of exposure (about 8%), this may easily be disregarded because of the available latitude of the film and the improbability of getting a 100% correct exposure at all times.

Some of the red filters, like the Wratten A or F may be used for many purposes. Although they are not strictly infra-red filters, since they do transmit a good portion of the visible part of the spectrum, they will produce effects quite similar to those obtainable with the regular infra-red filters when used in connection with Infra-Red films. It will be simply a matter of degree, but the exposure will be substantially shorter. These red filters are frequently known as *effect filters* because they are used to produce most striking effects of night scenes, moonlight scenes in broad daylight. In addition, these filters are also known as *haze-filters* because they have the rare property of eliminating aerial haze in distance photography, and in aerial photography. It should be remembered, however, that while these filters are very effective in eliminating aerial haze, they will not cut through air filled with smoke, dust, fog or steam.

While speaking of effect filters, the so-called *fog-filters* should be mentioned. These fog filters, unlike the haze-filters, are not used to eliminate fog from pictures, but, on the contrary, to put it into the picture! Fog-filters are decidedly misnamed. They are not filters but merely diffusion screens, which are available in a number of degrees of *softness* or *fog*. In skilled hands, these fog-filters produce truly remarkable results. But, as a matter of general practice, their use is not to be recommended. The small Leica negative should remain as sharp as possible. If softness is desired, it should be produced by means of illumination or by using an appropriate lens at the proper opening. All kinds of fog, and all degrees of softness and diffusion may be produced on the finished print by skillful manipulation of the enlarger, and the reader is cautioned against placing too much faith in such *filters* as are entirely satisfactory for, say, motion picture work, but barely desirable in Leica photography.

Just when to use a filter is often something of a mystery to a beginner. Obviously, it is a matter of that great combination of knowledge, experience and judgment. In order to assist the beginner, the following list is offered:

Yellow Filters: May be used with either ortho or pan films. Everything else being equal, a denser yellow filter should be used with the ortho than with the pan film. These filters are almost exclusively for cloud effects upon light blue skies. The lighter the sky the darker should be the filter.

Sky Filters: For use with all films. This filter has a lower half of clear glass, which from the center gradually changes into a yellow upper half. The purpose of this filter is to hold back the blue rays emanating from the sky only, without affecting the lower half of the image in any way. It requires no increase of exposure. One should be careful in using this filter that the center of the picture coincides with the line of the horizon. A most useful filter for landscapes and seascapes.

Green Panchromatic Filters: A filter specifically designed to enhance the comparatively low sensitivity to the green of panchromatic films. Its effect upon a panchromatic emulsion is similar to that of a yellow filter upon an orthochromatic emulsion. It holds back not only the blue, but also the red, to which this type of film is very sensitive. It is, therefore, useful in the same way for cloud effects, etc. Whenever Eastman panchromatic films are used, Wratten green panchromatic filters are recommended for best results. (X1 for daylight work and X2 for artificial light.)

U. V. Filter: To be used only in high altitudes, mountains, etc. Not for work from an airplane when photographing the earth! The layer of air acts as an efficient U. V Filter. This filter does in the mountains what a denser (yellow) filter does at sea level.

Red Filters: For extreme contrasts and effects, where **overcorrection** is intentionally aimed for in order to produce dramatic effects. Brilliant white clouds against a black sky. Moonlight effects with the sun substituting for the moon. Dramatic sunsets. To be used with panchromatic films only. The darker red filters are designed and intended specifically for infra red photography with Infra Red film.

Editor's Note.

Our readers will be interested to know that filters having transmission characteristics and factors similar to those of the Wratten type, are now available in many of the popular colors in solid glass form. These filters are made of optically flat glass not affected by temperature or climatic conditions. They are distributed in this country by the Chess-United Co., 160 Fifth Avenue, New York City, through their agents and dealers.

Filter Factor Table

The following table of filter factors is offered in the hope that it be used with a grain of salt. It is deliberately placed at the end of the chapter, trusting that the reader will not use it literally, but merely refer to it for general guidance and information. The factors are bound to change with varying light conditions. They should not be followed blindly, but when used intelligently may be helpful in getting the desired results.

FILTER FACTORS:

DAYLIGHT 2 MAZDA LIGHT 2 NOT RECOMMENDED – – NOT AVAILABLE

Each cell gives daylight / Mazda light.

LEITZ FILTERS

FILM	0	1	2	3	GREEN	RED I	RED II	RED III	U.V.
AGFA PLENACHROME	2 / 1.5	3 / 2	6 / 2.5	8 / 3	– / –	– / –	– / –	– / –	2
" FINOPAN	1.75 / 1.25	1.75 / 1.5	2.5 / 1.75	3 / 2.5	3.5 / 3	20 / 10	– / –	– / –	1.5
" SUPERPAN	1.75 / 1.25	1.75 / 1.5	2.25 / 1.75	2.75 / 2	4 / 2.75	16 / 10	– / –	– / –	1.25
" " REVERSIBLE	1.5 / 1.25	1.75 / 1.25	2.25 / 1.5	2.75 / 1.75	5 / 6	16 / 10	– / –	– / –	1.25
" INFRA RED						1/20 SEC. AT F:4.5 BRIGHT SUNSHINE			
DUPONT MICROPAN	1.5 / 1.25	1.75 / 1.5	2.5 / 1.75	3 / 2.5	3 / 2				1.5
" SUPERIOR	1.2 / 1.3	1.75 / 1.5	2 / 1.75	3 / 2.5	4 / 3				1.5
" INFRA D				16		32	32	64	
E. KODAK PANATOMIC	1.5 / 1.5	1.5 / 1.5	2 / 1.5	2 / 1.5	2.5 / 2	7 / 3	40 / 20	– / –	1.5
" SUPER SENSITIVE	1.5 / 1.5	1.5 / 1.5	2 / 1.5	2 / 1.5	2.5 / 2	7 / 3	40 / 20	– / –	1.5
" SUPER X	1.5 / 1.5	1.5 / 1.5	2 / 1.5	2 / 1.5	2.5 / 2	7 / 3	40 / 20	– / –	1.5
" PAN K. INFRA-RED (SENSIT.)						20 / 2	20 / 2	30 / 3	
GEVAERT EXPRESS SUPERCHROME	2.1 / 1.8	3.3 / 2.1	6.5 / 3.5	8.5 / 4	– / –				1.8
" PANCHROMOSA	2 / 1.3	2 / 1.6	2.9 / 1.8	3.2 / 2.7	2.9 / 1.8				2
MIMOSA EXTREMA	1.7 / 1.7	3.4 / 2.1	4.7 / 2.9	6 / 3	– / –				1.8
" PANCHROMA	1.5 / 1.4	2.1 / 1.8	3.1 / 2.5	3.5 / 2.7	2.8 / 2.3				2
PERUTZ NEO-PERSENSO	1.9 / 1.5	2.7 / 2.1	4.1 / 2.3	5.5 / 3	– / –				2
" PERPANTIC	1.8 / 1.5	2.8 / 1.6	3 / 1.7	4 / 2.5	3.2 / 2.4				2
" PEROMNIA	1.8 / 1.5	2.2 / 1.7	2.5 / 1.8	3.5 / 2.8	3.2 / 2.4				2.2

LEICA MANUAL

WRATTEN FILTERS

FILM	K1	K2	G	AERO 1	AERO 2	3N5	5N5	23A	A	F	70	B	C5	X1	X2
AGFA PLENACHROME	2 / 2	5 / 3	6 / 4	2 / 3	4 / 4			– / –	– / –	– / –	– / –			6 / 4	10 / –
" FINOPAN	1.8 / 1.5	2 / 1.8	3 / 2.5	2 / 1.8	3 / 2.5	5 / –	6 / –	6 / 3	10 / 5	32 / 16		14 / 11	7 / 12	6 / 4	10 / 7
" SUPERPAN	1.3 / 1.3	2.5 / 1.6	3 / 2	1.5 / 1.4	1.8 / 1.8	4 / –	5 / –	4 / 3	5 / 3	12 / 6		10 / 7	4 / 8	5 / 4	8 / 6
" " REVERSIBLE	1.8 / 1.5	2 / 1.8	3 / 2	1.8 / 1.5	2 / 1.8	3 / –	4 / –		4 / 2.5	8 / 4		15 / 12	10 / 20	4 / 3	20 / 15
" INFRA RED															
DUPONT MICROPAN	2.2 / 1.3	3.1 / 1.4	5 / 1.6	24	3.7	5.6 / –	8 / –	5.3 / 1.7	7 / 2.2	10 / 3.5	60 / 20	16 / 10	12 / 25	4 / –	8
" SUPERIOR	1.9 / 1.6	2 / 1.7	2.9 / 2.2	1.7 / –	2.7 / –	4.4 / –	6.3 / –	6 / 3	8.5 / 3.8	17 / 6.6	300 / 1.25	5.6 / 6.6	11 / 32	3.1	3.8
" INFRA D									64	64	64				
E. KODAK PANATOMIC	1.5 / 1.5	2 / 1.5	2.5 / 2	1.2 / –	1.5 / –	4 / –	5 / –	3	4.5 / 3	10 / 5		8 / 8	6 / 12	4 / –	– / 5
" SUPER SENSITIVE	1.5 / 1.5	2 / 1.5	2.5 / 2	1.2 / –	1.5 / –	4 / –	5 / –	3	4.5 / 3	10 / 5		8 / 8	6 / 12	3 / –	– / 5
" SUPER X	1.5 / 1.5	2 / 1.5	2.5 / 2	1.2 / –	1.5 / –	4 / –	5 / –	3	4.5 / 3	10 / 5		8 / 8	6 / 12	4 / –	– / 5
" PAN K. INFRA-RED (SENSIT.)															
GEVAERT EXPRESS SUPERCHROME	3	5													
" PANCHROMOSA	2.5	3												3.5 / –	
MIMOSA EXTREMA	3	5													
" PANCHROMA	2.5	3												3.5 / –	
PERUTZ NEO-PERSENSO	3	4													
" PERPANTIC	2.5	4												3.5 / –	
" PEROMNIA	2.5	3												4 / –	

Fig. 71 Moon Over the Empire State John T. Moss, Jr.
Elmar 50mm, 3 seconds at f:3.5. Photograph taken at 1 A.M. DuPont Superior Film

THE 35 MM FILM
SELECTION, EXPOSURE, DEVELOPMENT

HENRY M. LESTER

CHAPTER 4

The 35mm film used in standard motion picture cameras establishes for the Leica a valuable relationship. Because of the vast quantities of film which the motion picture industry consumes, the manufacturers of 35mm film go to no end of trouble to produce the greatest variety and finest quality of film. This in turn makes available to the Leica user an unlimited choice of negative material which the user of larger cameras does not enjoy. While this is a decided advantage to an experienced Leica worker, it is frequently confusing to the beginner.

It may be said, almost without reservation, that the modern 35mm film produced by large manufacturers is of excellent uniform quality throughout, regardless of its type. However, not all films are adapted to every kind of work. If they were, there would probably be no need for some fifty different types of 35mm film available. Some film emulsions have a wide range of application and may be considered more or less **universal.** The word **universal** is obviously a generality and as such is only measurably correct. Other films are designed to fill a specific need in the more specialized fields of photography.

Those Leica workers who do not concentrate upon the more specialized phases of photography, like photomicrography, aerial photography, clinical work, etc., but who want to obtain excellent photographs within the scope accessible to all photographic workers, will find that almost any good film of a standard make will answer their requirements—**provided they will get to know it through constant use and will understand its characteristics and its response to exposure and development.** On the other hand, those who are doing specialized work should select a film to answer that specific purpose. In either case, for consistently good results, once a film emulsion is decided upon, whether it be for portraiture, pictorial work or copying X-rays, **that film should be used always for that purpose,** to the exclusion of all others.

Success in photography, as in all other crafts, is based upon the ability of the worker to produce definite results. To produce them consistently the worker must know his equipment and materials thoroughly to make them do what he wants. Therefore: **know your film, learn what it can do and make it fit your purpose.**

Part I — Film Selection

The 35mm films should be considered from the following viewpoints as the first step in making the selection:

1. **Sensitivity to Color** . . . From this viewpoint the films are considered depending upon their response to various colors.

   Those that respond or are sensitive to all colors including red are known as *Panchromatic.*

   Those that are sensitive to all colors except the spectral red are known as *Orthochromatic.*

   The relative sensitivity of an emulsion to the various colors can be controlled by means of filters.

   Films that are not sensitized to distinguish between colors, except between black and white, are known as *Color-Blind.*

   Then there are the *Special Emulsions* required for color photography infra-red photography or direct positives.

2. **Speed of Emulsion** . . . From this angle the films are considered depending upon the relative amount of light required to form an image on the emulsion. This classification results in terming films as **fast, medium** or **slow.**

   The speed of a given emulsion can be controlled within certain limits by development.

3. **Graininess** . . . From this point of view the films are considered depending upon the size of the grain of the emulsion. The smaller the size of the grain, the more desirable the emulsion for Leica work.

   Although the size of the grain is inherent in each emulsion, being a definite part of its structure, its final size in the negative can be controlled by means of suitable development.

4. **Contrast** . . . From this viewpoint, we consider the emulsions as to their ability to render comparative degrees of brightness of the image. If the film is capable of rendering many shades or gradations of grays between black and white, it is known as **a low contrast** or **long scale** film. If the range of gradations of

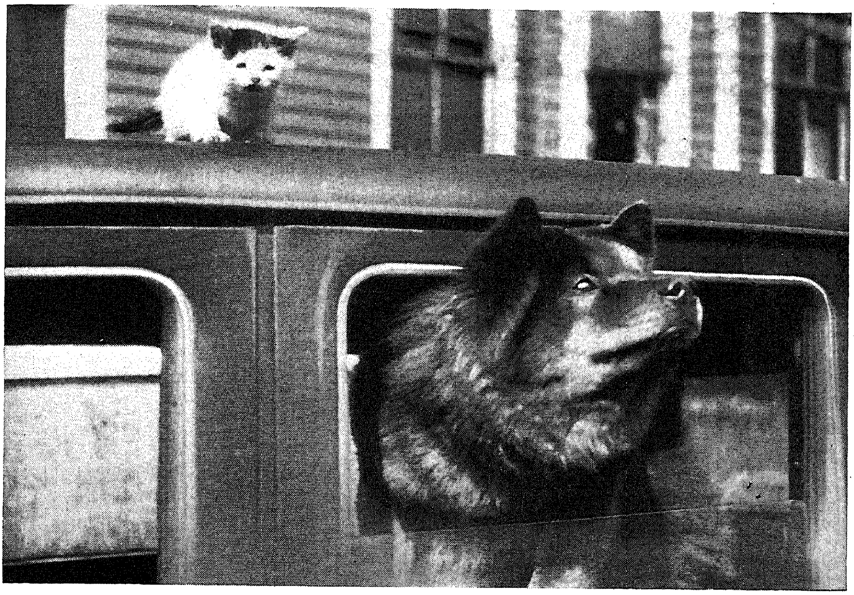


Fig. 72 I Smell Cat! Roland Smith

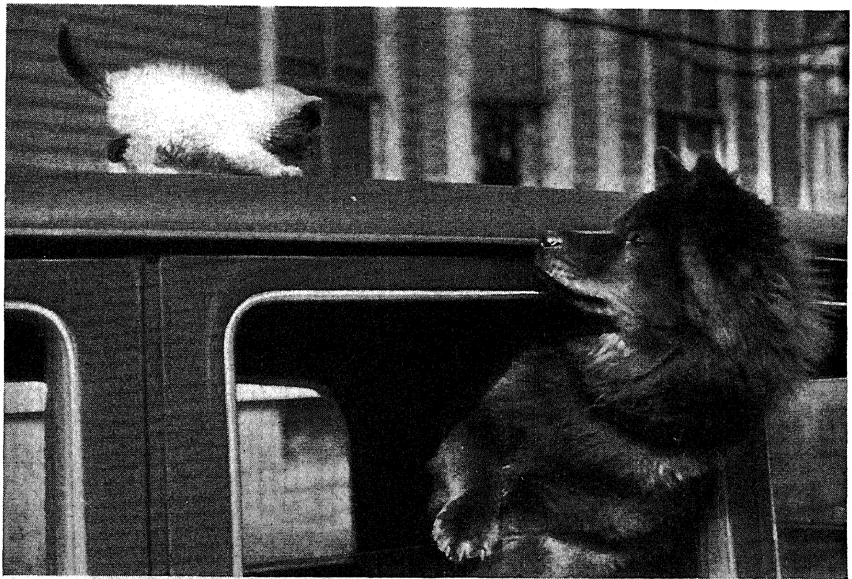


Fig. 73 Ah, There You Are! Roland Smith

gray between black and white is not great, the emulsion is known as one of **high contrast** or **short scale.** Generally, the finer the grain the greater the contrast and the shorter the scale.

Although contrast is substantially built into the emulsion, it can be most effectively controlled by exposure and development skilfully made to depend upon each other.

5. **Latitude** . . . Here we consider the film by its ability to react to various quantities of light admitted to it. It would be just too bad if every exposure would have to be ''on the button'', so to speak, to produce a usable negative. We therefore look to the emulsion for its ability to yield usable negatives with a certain amount of under or overexposure. Latitude is important to us not only because of the ever present danger of over or underexposure, but also because of the definite effect which we frequently want to produce by over and underexposure. Generally, the finer the grain of an emulsion, the less its latitude.

The latitude of the film is one of its inherent characteristics which cannot be readily controlled.

Selection to Fit the Purpose

An important factor of successful Leica photography which is not generally appreciated and understood is the necessity to choose a film to fit a definite purpose.

The general level of quality of Leica work could be raised considerably if the worker, instead of asking the dealer for the best and most expensive film, would consider these questions:

What is the film going to be used for?

In what developer will the film be processed?

What size enlargements will be required?

What type of paper will the enlargements be printed on (glossy, mat, rough)?

The size of the grain, as is generally known, increases with the speed of the emulsion. There is a vast field of photography where extreme speed of the film is not as essential as fineness of grain. The selection of the emulsion should therefore be made with a preference for fine grain rather than speed. This is made quite feasible by the growing availability and popularity of extremely fast and sharp lenses. However, where sufficient light is not available, or quick action must be recorded, fast films must be used and one must be willing to sacrifice the size of the grain and be satisfied with a smaller enlargement for the sake of getting the picture, which would be impossible without the fast film.

Types of Film

With a view to simplification of the multitude of emulsions available on the market, a classification into five groups is offered. It should be remembered that while each of these grouped emulsions has its own distinctive characteristics, they have a good deal in common, and the grouping is offered for simplicity. Also as a means of expediency, not all the emulsions are being listed, but only those whose popularity makes them readily available in either bulk or daylight loading packages.

Group No. 1 Panchromatic Emulsions (Fast)

Agfa Superpan
DuPont Superior
Eastman Kodak Super-X
Eastman Kodak Super-Sensitive
Gevaert Panchromosa
Perutz Peromnia, etc.

The films of this group are fully **panchromatic,** being sensitive to all colors, including red. These emulsions are not alike in their **relative** response to the various colors of the spectrum. For extremely critical color corrections spectrographs of each emulsion should be consulted. (These spectrographs are readily obtainable from the respective manufacturers.)

The most distinguishing feature of the emulsions of this group is their **speed:** their all-over great sensitivity to light, both daylight and Mazda. Their speed rating in daylight is 23° Scheiner or 24 to 32 Weston, and in Mazda light 20° Scheiner and 16 Weston. The emulsions of this group are of the **low contrast** and soft gradation type. The degree of contrast of these films can successfully be controlled in development. They possess excellent latitude and will yield usable negatives resulting from several times under or overexposure. Their graininess is consistent with their high speed.

Group No. 2 Panchromatic Emulsions (Medium Fast)

Agfa Finopan
DuPont Micropan
Eastman Kodak Panatomic
Perutz Perpantic, etc.

The films of this group are fully **panchromatic,** the same as those in Group No. 1, being sensitized to all colors. The particular distinction of these emulsions is the exceptional fineness of grain combined with good all-over sensitivity, which places them in the **medium fast** class. Their speed rating averages from 18° to 20° Scheiner or from 8 to 16 Weston in daylight, and from 14° to 17° Scheiner or from 4 to 8 Weston in Mazda light.

The latitude of the films of this group is not as great as that of Group One but still considerable, and can be controlled in development. Generally, films of this group are of the "brilliant" type, yielding negatives of high contrast and consequently of a shorter scale.

Group No. 3 Orthochromatic Emulsions

Agfa Plenachrome
Gevaert Express
Mimosa Extrema
Perutz Neo-Persenso, etc.

The emulsions of this group are fine representatives of the popular **orthochromatic** type. They are sensitive to all colors, except the spectral red, with a high sensitivity to green. These films combine extreme fineness of grain with extreme speed to daylight. Their definition is excellent and the gradation quite complete. They belong to the "brilliant" type characterized by **high contrast** and a medium long scale. Their speed rating in daylight is approximately Scheiner 23°, Weston 24.

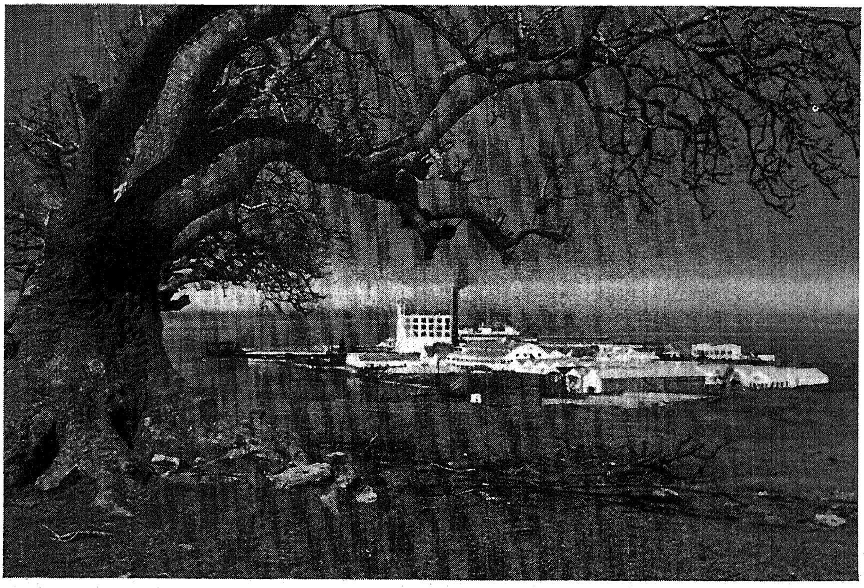


Fig. 74 Montevideo, Uruguay Burton Holmes

Group No. 4 Color-Blind Emulsions

This group includes only **positive film**, which is produced by every manufacturer of negative film. Positive film is sensitive only to the blue and violet colors of the spectrum. The distinguishing features of positive film are its extremely fine grain, high resolving power, excellent definition and extremely high contrast. The length of its scale of gradation is rather short, but this depends greatly upon exposure and developing procedure. The speed rating for positive film in daylight is about Scheiner 8°, Weston 1. It is difficult to give its speed rating for artificial light because it is entirely dependent upon the amount of blue light in the particular light source.

Group No. 5 Special Emulsions

A. Films for Color Photography

Agfacolor
Dufaycolor
DuPont Bi-Pack
Eastman Kodak Zulcras Bi-Pack
Eastman Kodak Kodachrome
Lumiere Film Color, etc.

Each of these films represents a definite system in itself, and

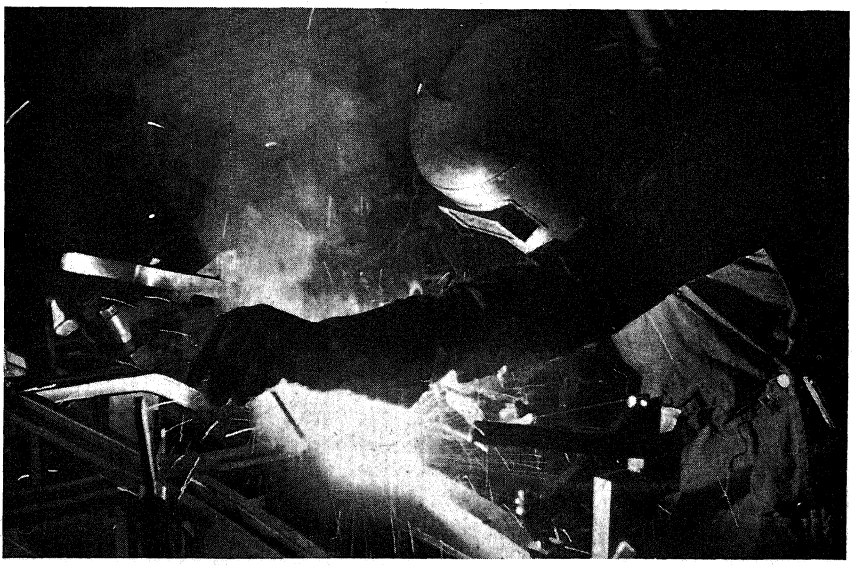


Fig. 75 The Welder — Ed. Schaefer

complete information pertaining to their characteristics is beyond the scope of this chapter.

B. Infra-Red Films

Agfa Infra-Red
DuPont Infra-D
Eastman Kodak K

These films are **panchromatic** with the sensitivity to red extending beyond the visible red portion of the spectrum. Their sensitivity extends to light waves of from 700 to 1000 millimicrons. Without special filters these films can be used as par speed panchromatic emulsions. It is difficult to give the numerical speed rating of these films when used with special infra-red light filters. Without these special infra-red light filters they rate about 17° Scheiner or 8 Weston, in daylight; but these figures are to serve merely as approximations. Infra-red films are rather coarse grained, and their gradation, contrast, color properties depend largely upon the subject matter and use to which they are put.

C. Agfa Reversible Superpan

This is an interesting new emulsion intended for direct positives secured by reversal. This film cannot be developed to a negative. It was designed for direct production of positives to be viewed as stereo pictures by projection or by transmitted light. Another interesting application of this film material is for production of paper negatives or enlarged negatives by direct projection. Its speed rating in daylight is 20° Scheiner or 16 Weston, and in Mazda light 19° Scheiner or 12 Weston. See page 126 for processing formulas.

Emulsion Speed Values

Definite speed ratings for each emulsion are not given here. Speed ratings are merely relative values. They are useful only in connection with given exposure meters. Every good exposure meter is accompanied by a complete list of speed ratings of almost every film known. One should refer to these lists for such specific information and apply it judiciously.

The various emulsion speed values now used cannot, in general, be compared directly with each other, except possibly H & D and the Weston speed values, for the reason that they are based on entirely different principles.

The Scheiner and Din speed numbers have no definite relation to each other nor to the other speed values except for emulsions having the same characteristics which, however, are quite different for the various kinds of commercial films or plates.

Fig. 77 After the Catch — Manuel Komroff

Hektor 50mm lens, 1/100 second at f:4.5. DuPont Superior film

To give a rough idea of the relation of the various speed values a comparison is given below for a type of film having the same characteristic as an ordinary commonly used film, but as stated above, the relative values do not hold for other types of emulsions and must, therefore, be used with due caution.

For example, a report of an actual test shows that 26° Scheiner may be equivalent in Din degrees to any value from 12/10° to 17/10° Din, which corresponds to a ratio of over 3 to 1 in sensitivity. Further, 18/10° Din may be equivalent in some emulsions to 65 Weston and in others to 24 Weston.

Comparative Table of speed ratings of various Systems.

CAUTION—Do not use this table without reading above.

Relative Value	Weston	Scheiner	DIN	H & D
18.3	3	14	7/10	159
23.4	4	15	8/10	200
29.8	5	16	9/10	252
37.9	6	17	10/10	318
48.3	8	18	11/10	400
61.6	10	19	12/10	504
78.5	12	20	13/10	635
100	16	21	14/10	800
127	20	22	15/10	1000
162	24	23	16/10	1270
207	32	24	17/10	1600
264	40	25	18/10	2020
336	50	26	19/10	2540
426	64	27	20/10	3200

Following are suggestions of the type of film to be used for best results in different kinds of work. The recommendations refer to groups of similar emulsions (see above); the choice of any one film is left to the worker:

		Group of Film Suggested
Aerial	Depending on light conditions, density and color of filters employed	**1** or **2**
Action and Sport	In daylight	**3**
	In artificial light	**1**
Architectural	Exteriors alone	**3** or **2**
	Both exteriors and interiors	**1** or **2**
Candid	Including child and animal photography	**1**
Copying	Blue-prints (with red filter)	**2**
	Black and white drawings, charts, line work, documents and other printed matter in black and white where good contrast is required	**4**
	Coins, stamps, paintings, fabrics or any other small or large objects containing color or requiring use of filters for better contrast	**2**
	Photographs in good condition	**3**
	Photographs, old or faded where use of red filter is required	**2**
	Transparencies, black and white, finger prints, X-rays, etc.	**3**
	Transparencies containing color	**2**

Entomology (insects etc.)	....	1 or 2
Flowers-Plants-Gardens	....	1 or 2
Geology (minerals)	....	2 or 3
Landscape and Pictorial	If true color correction is required	1 or 2
	If great enlargements and fine grain are preferred...........	3
Medical	For general use, and for adverse light conditions	1
	If adequate illumination is available	2
	Dental work	1
	Dermatology	3
	Ophthalmology	1
Night and Stage	....	1
Photomicrography	If color filters are required.....	2
	If no color filters are required..	3
	For living organisms..........	1
Portraiture	If adequate illumination is available	2
	For adverse light conditions....	1
General Use	For beginners	3
	If outdoor in daylight..........	3 or 2
	If entirely or partly indoor, or entirely or partly under artificial light	2 or 1
Natural Color	....	5 A
Infra-Red	....	5 B
Reversal Transparencies	....	5 C

Daylight Loading and Bulk Film

All films mentioned here, and many others, are available in two forms:

1. **Daylight loading spools or cartridges** containing from 30 to 36 exposures.
2. **Bulk** in rolls containing 25, 50, 100, 200 or 400 feet.

The daylight loading packings are lengths of film from 5 to 6 feet, cut and trimmed ready for loading into the camera. Some packings have a paper leader strip and are used in connection with the regular Leica camera magazine. Others are sold in the form of ready-to-use cartridge magazines which are loaded directly into the camera. For convenience and ready availability daylight loading packings are most desirable.

Bulk film has many advantages, including that of considerably lower cost. When purchased in original manufacturer's packages it is more likely to be free from scratches and abrasion marks than film obtained in daylight loading units. Those who need and appreciate uniformity of film will find that bulk film offers it, since a roll of say 100 feet is the same throughout, and once its characteristics become known to the user, they can be depended upon as long as this supply is used. Bulk film also offers the advantage that it can be cut to any desired length, enough for forty exposures or perhaps only five. It is recommended to buy bulk film in so-called "automatic camera" packages consisting of solid metal spools, which provide a most satisfactory method for storing and handling film, protecting the emulsion and edges against excessive contact with fingers. BULK FILM SHOULD BE HANDLED WITH EXTREME CARE and its use should not be attempted by workers lacking the necessary experience.

Part II — Film Exposure

The last decade has witnessed an interesting trend in the field of photography. Both the professional and amateur workers had gradually become exposure conscious. They began to realize that every important characteristic of the finished photograph takes its root at the time the exposure is made, and that the desired result depends upon their ability to coordinate judicious exposure with skilful development of the negative.

The Leica camera is in a great measure responsible for this realization. Leica photography has established a definite system based on the successful application of a number of principles. One of these principles is a certain uniformity of exposures, since as many as thirty-six negatives are usually developed at the same time, and individual negatives cannot be controlled in the development.

This requirement of Leica photography brought about the interest in **normal exposure.** Normal exposure is that which places the range of brightness somewhere in the middle of the limits of the latitude of the emulsion. In terms of every day work normal exposure strikes a compromise between the light and dark portions of the subject so that the bright portions are not overexposed while details in the shadows are recorded too

From this point, within the limits of the latitude of a given emulsion, a range of exposures favoring either the shadow details or the highlights is available, depending upon whether the predominant part of the photograph is to bring out the dark or light portion of the subject. Which brings us to the matter of **correct exposure. That exposure is correct which puts on film exactly what is wanted in the picture.**

A great variety of exposure meters and tables is available to assist us in obtaining normal exposures. But correct exposures do not necessarily mean normal exposures. While normal exposures are within reach of every owner of a reliable exposure meter, correct exposures require judgment and skill on the part of the photographer—the knowledge of when and how to use over or underexposure to get what is wanted in the picture. This knowledge comes with practice and experience.

Exposure Meters

Exposure meters are essentially of three types:

1. **Exposure tables and calculators** are helpful guides to normal exposures based on compiled actual experiences. Some of these are available in the form of direct tables which suggest approximately normal exposures for different emulsions and for various subjects, taking into consideration time of day, location, season, weather, etc. Others are put up in the form of slides or discs made of cardboard, celluloid, etc. Then there are some in the form of booklets containing in addition to suggestions concerning exposures a variety of information, references, etc. The chief merit of all of these lies in their providing **some basis** for arriving at a more or less normal exposure.
2. **Visual exposure meters** which are frequently known as the "extinction type" require sighting the subject through a ground or tinted glass screen while the amount of light admitted is gradually reduced to a minimum. When that minimum is reached a scale indicates the desired data. The greatest disadvantage of this type of meter is the impossibility to assume a standard sensitivity of the eye to light. Its chief advantage is its ability to give readings in extremely unfavorable light conditions of interiors and night photography. Any one of these instruments, if used consistently and with judgment, will provide usable information as to normal exposure.
3. **Photometric exposure meters** are the latest and to date most accurate and dependable means for ascertaining normal exposures. They are usually made as instruments of great accuracy and precision, and should be handled as such. The instruments are built around a photoelectric cell which converts light energy into electrical energy, which in turn activates extremely sensitive miliammeters calibrated in terms of light values. Such popular photoelectric instruments as the Weston or the Photoscope, though comparatively expensive, belong actually to those self-liquidating investments which earn their price through constant economies of film, elimination of uncertainty and securing results.

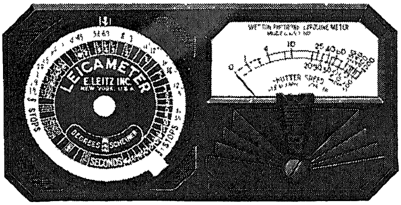


Fig. 78 Weston Photoelectric
Leicameter, New Model No. 650

Any of these exposure meters when used strictly in accordance with manufacturer's instructions will yield results of surprising accuracy. Each has its own advantages and a careful comparison of them should be made before deciding which one will answer individual requirements. It is difficult to make specific recommendations because of the vastness of the field which Leica photography covers today.

There are no factotums in photography. The more one knows about photography the more difficult it becomes to point specifically to any one film, exposure meter, lens, developer, paper and attach the term "universal" to it. Only a careful examination of the product and scrutiny from the viewpoint of what it is expected to perform will determine its usefulness.

No matter what the relative merit of any of these meters may be, it is safe to state that the consistent use of any one of them will yield results far superior to those obtained by guesswork.

How to Use an Exposure Meter

An exposure meter, very much like a lens, has a very definite field coverage, varying with the make. The manufacturer supplies this information with every instrument. The area covered should be thought of as the base of a cone whose apex is in the center of its light sensitive surface. The angle of this apex varies anywhere from 50° to 70°.

It should be remembered that a meter has no power of selectivity. For instance, if a reading is taken of a dark object back of which is a light surface, the meter will give a reading proportionate to the relative amount of light and dark portions of the entire area which it "sees". One should endeavor, therefore, to take a reading by holding the meter as close as possible to the object for whose detail the exposure is to be made. The meter should be held in a manner to prevent its shadow being cast on the area under observation.

When taking the reading of small objects occupying only a small portion of their background, the proper way to secure a correct reading is by the method of substitution. A sheet of paper or fabric of a color and brightness approximating that of the small object should be placed over the object and its background and a reading secured from that. For instance, if teeth are photographed and the meter directed on the face or mouth, considerable overexposure of the teeth would result, because the skin and lips are darker than the teeth. However, if a piece of ivory tinted paper is placed over the face and the meter directed on that, a correct exposure of the teeth will result, while the lips and skin will be somewhat underexposed. This example is quoted merely in the hope that it will assist in the judicious use of exposure meters. Here again, the *purpose* of the picture must be borne in mind.

Needless to say, instructions accompanying every instrument should be read and followed carefully.

Fig. 80 Doug
Barbara Morgan
Summar 50mm lens,
1/100 second at f:6.3
DuPont Superior film

How to Make Exposures Without an Exposure Meter

If an exposure meter is not readily available, or if there be no time to use one, the following method is recommended:

Set your shutter speed at 1/30 or 1/40 of a second.

If the sun is shining unobstructed by clouds, make three exposures of the subject: one with the lens set at f:6.3, one at f:9, and one at f:12.5.

If the sun is obstructed by clouds (no shadows cast), take three exposures of the subject: one with the lens at f:6.3, one at f:4.5, and one at f:3.5 (or larger opening if available).

This rule-of-thumb method seldom fails to produce at least one usable negative out of three taken. When in extreme doubt make a fourth exposure either at a larger or smaller opening than indicated above. Remember your film is the least expensive part of your equipment while opportunities for pictures rarely repeat themselves.

Exposures for Photoflash

Average Distance Covered by One General Electric Mazda Photoflash Lamp in a Reflector

Diaphragm Opening	Size of Photoflash Lamp	Approx. Distance of Lamp to Subject: Ortho Film Group No. 3	Approx. Distance of Lamp to Subject: Super-sensitive Pan Group No. 1 Film
f:18	No. 10	5 ft.	7 ft.
	No. 20	7	10
f:12.5	No. 10	7	10
	No. 20	10	15
f:9	No. 10	10	15
	No. 20	15	20
f:6.3	No. 10	15	20
	No. 20	20	30
f:4.5	No. 10	20	25
	No. 20	25	35

These figures are based on a room with medium colored walls and ceiling. Where pictures are made outdoors or under adverse conditions at the greater distances, use the next larger diaphragm opening or reduce distance from lamp to subject to about 70 per cent of that shown.

Part III — Film Development

Development with Relation to Exposure

Leica negatives will produce excellent enlargements if they meet two requirements:

1. Fineness of grain.
2. A comparatively low degree of contrast.

Both of these conditions can be met by carefully selecting the negative material and **by coordinating the exposure with the development.**

Leica negatives must be processed with low energy developers which act gently and slowly. Development is carried out on the time-and-temperature principle.

Most fine grain developers adopted for Leica work are carefully and scientifically compounded to act uniformly and to produce predetermined results. It is not necessary to delve into details of sensitometry to obtain such predetermined results. To provide a means

of comparison of densities and contrasts, scientists have evolved a definite system. The unit in which the functional dependence of density, contrast and exposure is expressed is the term **gamma** (γ) which is defined as a numerical expression for the contrast of the negative obtained from a range of given exposures carried out in a given developer in a given time.

Depending upon the size of the finished enlargement, the gamma of Leica negatives should vary between .6 to .8. The lower value, which stands for lower density and contrast, should be aimed at for greater enlargements; while the higher value for smaller enlargements. Gamma of approximately .7 will be found excellent for all-around purposes, and it is the gamma value of .7 on which the time-and-temperature units should be based for the various fine grain developers.

Density and contrast of a negative corresponding to gamma value .7 are based upon **normal exposure.** Consequently, underexposures with the same development will result in higher contrast and less detail in the shadows; while overexposure under the same developing conditions will result in lower contrast and more detail in the shadows.

The time-and-temperature factors for a given developer to produce gamma .7 stand for minimum development. This minimum is necessary to assure fineness of grain and low contrast. If development is carried beyond that minimum, it is likely to increase both graininess and contrast. In order that development be held to this minimum and still bring out as much detail in the negative as possible LEICA NEGATIVES MUST BE FULLY EXPOSED. Briefly: OVEREXPOSE—UNDERDEVELOP! . . . within reason of course. To put this in terms of practical application, the film speed ratings usually published should be considered as somewhat over-rated, and for best results the films should be used at ratings slightly below the "official" ratings.

Developing Equipment

The equipment for developing Leica film is extremely simple, easy to handle and with proper care will last a lifetime.

For convenient development of Leica film there are two tanks, the Correx and the Reelo. There is also a glass developing drum. Instructions for handling accompany each one. The tanks should be used preferably in all cases, except for reversal where the developing drum alone or in connection with one of these tanks is recommended. The greatest advantage of developing Leica films in one of these tanks is the fact that no dark room is needed for the process. Once the film is transferred into the tank (this can be accomplished in a changing bag), the development and subsequent handling do not require darkness.

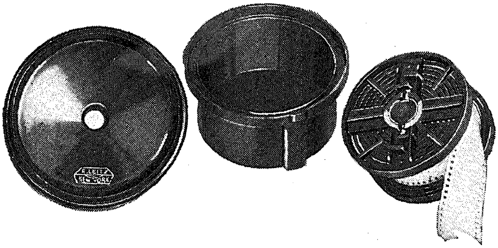


Fig. 81 The Reelo—All Bakelite Developing Tank

These two tanks differ from one another by the method in which separation of the film layers is accomplished. In the Correx tank the film is separated by means of a celluloid apron with studded edges, while in the Reelo tank it is separated by the grooved spool. The tanks are equally effective and selection between them is a matter of personal preference.

The capacity of the Correx tank is about 500.0 cc, or 16 ounces; and that of the Reelo about 400.0 cc, or 12 ounces.

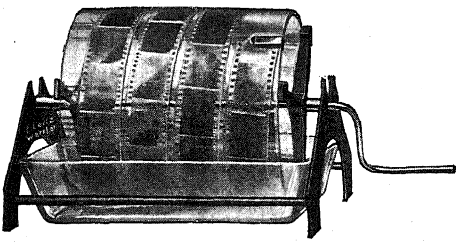


Fig. 82 Glass Developing Drum and Tray

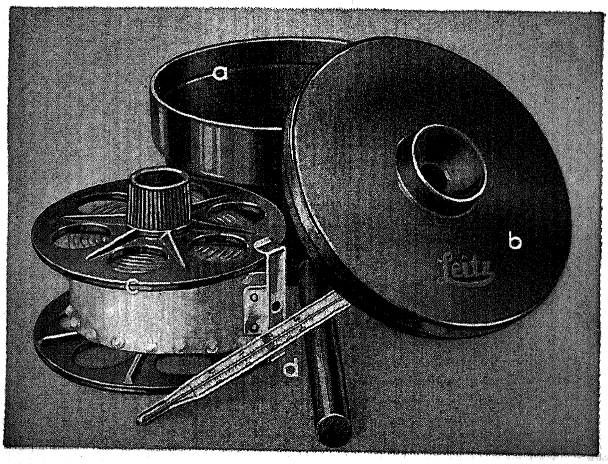


Fig. 83 The Correx—All Bakelite Developing Tank with celluloid Studded edge Apron and Thermometer

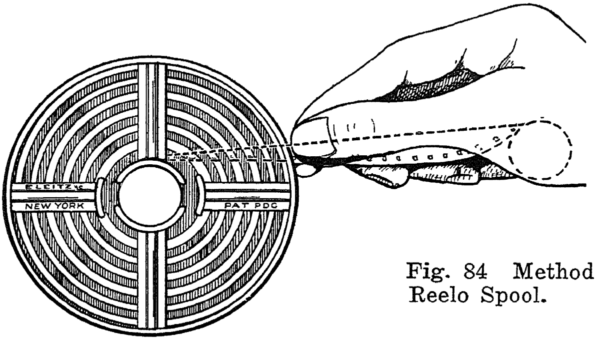


Fig. 84 Method of Winding Film upon Reelo Spool.

Developers

Those who wish to process their films themselves may use any one of the prepared ready-to-use developers on the market, which are available either in powder form or in concentrated liquid form. These preparations will give excellent results if used strictly in accordance with manufacturer's directions.

A more economical and possibly more practical way to produce excellent negatives is to prepare one's own developer as well as other solutions required for processing Leica negatives. A few simple chemicals, a scale and a few graduates, are all that is necessary.

The number of formulas offered for fine grain development is enormous. A careful study of them reveals the important fact that in addition to some processes which have purely experimental merits, there are only two classical basic formulas available. Others are merely modifications of these two:

1. **The Metol Hydroquinone Borax type.**
2. **The Paraphenylene Diamine type.**

The first type represents a developer which, as far as miniature camera work goes, can be termed the **maximum energy developer.** It will bring out details in shadows and underexposed portions of the negative to a remarkable degree, while it will produce granularity of sufficient fineness to yield excellent enlargements up to 8x10″.

The second type is a **low energy,** extremely fine grain developer which requires a fuller exposure than the first type, but in return will yield negatives of such fine grain, excellent definition, and low contrast that enlargements of 16x20″ can easily be obtained.

Reference to fine grain performance of these two developers is made specifically in connection with films of Group 1, which due to their speed have an inherently coarser grain structure.

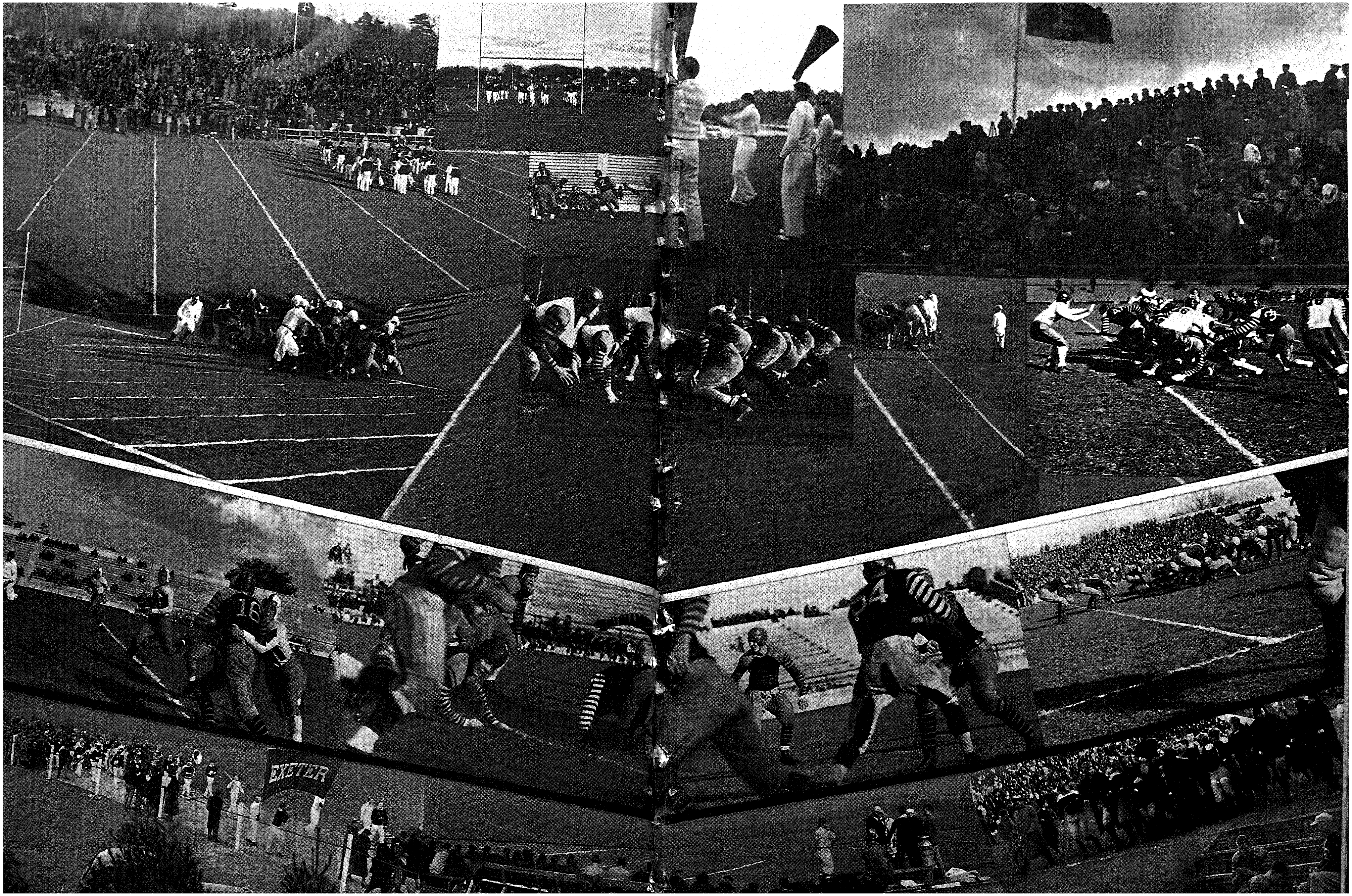


Fig. 85 Football Montage—The 1936 Pean Designed by Barbara Morgan
Designed for preparatory school annual, Phillips Exeter Academy, Exeter, New Hampshire. Individual photographs by students of Phillips Exeter Academy who covered all games and events with the Leica—Barbara Morgan designed a series of fifteen different montages of various school activities. This is an example of paste up montage—the simplest type using many individual pictures.

Developing Formulas

The Metol-Hydroquinone-Borax type of fine grain developer is represented by the classical formula known as Eastman Kodak D-76, or its derivative the Modified E.K.D-76, also known as Buffered Borax.

E.K. Formula D-76

	Avoirdupois		Metric
Water (about 125°F. or 52°C.)	24	ounces	750.0 cc
Metol	29	grains	2.0 grams
Sodium Sulphite, desiccated	3 1/3	ounces	100.0 grams
Hydroquinone	73	grains	5.0 grams
Borax (the 20-Mule Team variety)	29	grains	2.0 grams
Cold water to make	32	ounces	1.0 liter

Dissolve the chemicals in the order given.
Use without dilution.
Develop 16 to 22 minutes at 65°F. or 18°C. for films of Group 1 or 3.
Develop 12 to 18 minutes at 65°F. or 18°C. for films of Group 2.
This formula can be re-used and the quantity is sufficient to develop from 8 to 10 Leica film lengths.

Modified E.K. Formula D-76 (Buffered Borax Negative Developer)

	Avoirdupois		Metric
Water (about 125°F. or 52°C.)	24	ounces	750.0 cc
Metol	29	grains	2.0 grams
Sodium Sulphite, desiccated	3 1/3	ounces	100.0 grams
Hydroquinone	73	grains	5.0 grams
Borax (the 20-Mule Team variety)	29	grains	2.0 grams
Boric Acid, crystals	203	grains	14.0 grams
Cold water to make	32	ounces	1.0 liter

Dissolve the chemicals in the order given.
Use without dilution.
Develop 20 to 22 minutes at 65°F. or 18°C. for films of Group 1 or 3.
Develop 16 to 18 minutes at 65°F. or 18°C. for films of Group 2.
This formula can be re-used and the quantity is sufficient to develop from 8 to 10 Leica film lengths.

The two developers given above should be used for films of Group 1 in all cases where it is known that the film has received the minimum possible exposure due to adverse light conditions (such as encountered in stage, night, candid and actions photography).
They are excellent standard developers for all films of Group 2 and 3.

The Paraphenylene Diamine type of fine grain developer is embodied in a comprehensive set of four formulas designed by Dr. Sease of the DuPont Film Laboratories. These four formulas are remarkable for their delicately balanced proportions of the same three ingredients: Sodium Sulphite, Paraphenylene Diamine and Glycin, with the latter gradually increasing:

DU PONT (Dr. SEASE) FINE GRAIN DEVELOPERS

	No. 1 Avoir.	No. 1 Metric	No. 2 Avoir.	No. 2 Metric	No. 3 Avoir.	No. 3 Metric	No. 4 Avoir.	No. 4 Metric
Water (ab. 135° F. or 57° C.)	24 oz.	750.0 cc	24 oz.	750.0 cc	24 oz.	750.0 cc	24 oz.	750.0 cc
Sodium Sulphite, des.	3 oz.	90.0 grams	3 oz.	90.0 grams	3 oz.	90.0 grams	3 oz.	90.0 grams
Paraphenylene Diamine	146 grains	10.0 "	146 grains	10.0 "	146 grains	10.0 "	146 grains	10.0 "
Glycin			15 grains	1.0 "	88 grains	6.0 "	175 grains	12.0 "
Cold water to make.........	32 ounces or 1 liter							

Dissolve all chemicals in the order given.

Time to reach gamma .7 Stagnant development at 68° F. or 20° C. (occasio nal agitation)

Emulsion	No. 1 Minutes	No. 2 Minutes	No. 3 Minutes	No. 4 Minutes
Superior (Group 1 or 3)....	32	22	17	15
Infra D (Group 5B).......	42	27	19	17
Micropan (Group 2).......	14	11	9	9

Gamma for time and formulas indicated for emulsions listed on the left. Stagnant development at 68° F. or 20° C.

Emulsion	Minutes	No. 1	No. 2	No. 3	No. 4
Superpan	14′	.41	.49	.62	.64
(Group 1 or 3)	28′	.67	.80	1.09	1.05
	42′	.82	.98	1.34	1.30
Infra D	14′	.44	.50	.64	.70
(Group 5B)	28′	.62	.70	.89	.99
	42′	.70	.79	1.01	1.12
Micropan	14′	.72	.84	.94	1.02
(Group 2)	28′	1.02	1.17	1.32	1.43
	42′	1.14	1.32	1.49	1.58

Use without dilution.
These four formulas can be re-used and each 32 oz. or 1 liter is sufficient to develop from 8 to 10 Leica film lengths.

Formula number 3 should be considered standard.

Formula No. 1, which yields the finest possible grain, requires from three to four times the **normal** exposure for the Superior (Group 1 or 3) film or the Infra D (Group 5B) emulsion but requires little or no increase of exposure for the Micropan (Group 2) film.

Formulas No. 2, 3 and 4, which yield very fine grain (the finer the less Glycin the formula contains), require about two times the **normal** exposure for the Superior (Group 1 or 3) film or the Infra D (Group 5B) film, but require little or no increase with Micropan (Group 2).

These requirements for overexposure should be considered as merely approximate and as referring actually to minimum exposures when these films are used under inadequate light conditions. One may interpret the latent image formed on the emulsion as having a certain amount of inertia which is greater the lower the energy of the developer. Thus the greater the so-called threshold value of the light that strikes the emulsion, the easier it is for these low energy developers to "pull up" the image. Consequently when exposures are made in full brilliant light, the requirements for overexposure stated above are not as great as those under adverse light conditions.

Compromise Developers

Neither of the two types of developer described above is entirely satisfactory for certain kinds of work where photographs taken under extremely poor light conditions must be considerably enlarged. Such a situation is frequently encountered in stage, action and candid photography. For such purposes "compromise" formulas were evolved which produce excellent shadow detail, gradation and contrast, combined with exceptionally fine grain—in cases where only minimum exposures were possible.

Two such formulas are offered, either of which is a modification of Dr. Sease No. 3 formula:

Pyro Fine Grain Formula for Not Fully Exposed Negatives

	Avoirdupois	Metric
Water (about 135° F. or 57° C.)	**24 ounces**	**750.0 cc**
Sodium Sulphite, desiccated	**3 ounces**	**90.0 grams**
Paraphenylene Diamine	**146 grains**	**10.0 grams**
Boric Acid	**14½ grains**	**1.0 gram**
Cold water to make	**32 ounces**	**1.0 liter**

Dissolve chemicals in the order given.
Directly before using add to every 500cc (16 ounces) of the above solution:

Pyro Crystals	**43½ grains**	**3.0 grams,**

filter and cool to 65° F. or 18° C.
Develop 30 minutes for films of Group 1 or 3.
This developer cannot be re-used after addition of Pyro.
Store it without Pyro.

The other compromise formula is based on the well known property of Metol to bring out shadow detail and gradation.

Metol Fine Grain Formula for Not Fully Exposed Negatives

	Avoirdupois	Metric
Water (about 125° F. or 50° C.)	24 ounces	750.0 cc
Paraphenylene Diamine	146 grains	10.0 grams
Glycin	73 grains	5.0 grams
Metol	88 grains	6.0 grams
Sodium Sulphite	3 ounces	90.0 grams
Cold water to make	32 ounces	1.0 liter

Dissolve chemicals in the order given.

Use without dilution.
Develop 18 minutes at 65° F. or 18° C. for films of Group 1 or 3.
Develop 12 minutes at 65° F. or 18° C. for films of Group 2.
This formula can be re-used and the quantity is sufficient to develop from 8 to 10 Leica film lengths. It definitely improves with age and use.

The developers described cover practically the entire range of Leica photography, and although there are hundreds of fine grain formulas offered almost every day, as matters stand now these should be considered best suited to successful Leica photography. These developers were chosen because of their simplicity, limited number of ingredients, for their comparatively rapid action and for their dependability. If used strictly in accordance with instructions they can be depended upon for consistently uniform negatives.

Although the following statement holds true of almost every phase of photographic procedure, it is of particularly great importance in connection with the preparation and use of developers: **A person not following a recommended procedure is, at present, entering a field of research where definite results cannot be promised.**

Conservative use of developers which can be re-used permits the development of 8 to 10 Leica rolls per 1000.0cc (32 ounces) of developer **with an increase of one minute developing time per roll processed,** i.e., one minute increase for the second roll, two minutes for the third roll, etc.

Any one of the above formulas (except the Pyro "compromise" formula) can be re-used within reasonable standing periods, but exact figures as to their keeping qualities would be of little direct value because conditions of use and storage differ widely.

Between developments the solutions should be stored in nearly full well-stoppered amber glass bottles with a special label provided for marking the developer every time it is used. The developer should be poured back into the original bottle after each use, until it has been used on 8 to 10 rolls, after which it should be discarded or set aside for "priming" the next batch of developer.

It is worth noting that most fine grain developers produce finer grain and lower contrast the older they are or the more they have been used. Most freshly prepared developers work more energetically than those somewhat aged and used. The fresh solutions have that "fire" in them; and for those who wish slightly softer results and finer grain it is recommended that they "prime" the developer either by adding some 25% of

the same developer ready to be discarded, or by developing in the fresh developer a length of say 5 to 6 feet of fogged film. This produces a certain amount of oxidation in the developer which takes the "fire" out of it and softens its action.

Temperature of Developers

Suggestions given in every developer formula for a temperature at which the development is to be carried out should be followed strictly. At temperatures below those indicated the developing agents may be partly or completely inactive; while at temperatures higher than those indicated the rate of development may be accelerated with resulting increase in graininess, density and contrast.

Agitation

As a general rule continuous and vigorous agitation is definitely to be avoided when developing for finest grain. Continuous agitation increases the rate of development, which actually should be compensated for by shortening the time. However, this would require a careful study of systematically developed test strips to insure uniformity of results, which would depend upon the type of agitator, its speed, direction, etc.

Occasional gentle agitation every three to five minutes, however, is not only recommended but urged. Such agitation does not increase the rate of development nor affect the time indicated, and is required to prevent streaking along the perforations of the film.

The Short-stop and the Fixing Bath

Before proceeding with the details of actual development, one should be familiar with the only other two solutions required for complete processing of Leica films:

The Intermediary Short-stop and Hardening Bath. The following solution seems to have many features which should make it indispensable in the processing of Leica films:

Intermediary Short-stop and Hardener

	Avoirdupois	Metric
Water	16 ounces	500.0 cc
Chrome Alum	145 grains	10.0 grams
Sodium Bisulphite	145 grains	10.0 grams

Dissolve Chrome Alum completely before adding Sodium Bisulphite; stir until Sodium Bisulphite is completely dissolved.
Use without dilution.
This solution should be used at the same temperature as that of the developer.
Film should be left in this bath for five minutes.
This solution should be prepared just before required and discarded once used.

Actual use of this short-stop on hundreds of rolls of Leica films proved its value. It gently checks development and gradually hardens the emulsion, the hardening process being continued in the acid fixing bath which follows. This intermediate bath seems to correct the acidity of the subse-

quent acid fixing bath to a degree which eliminates the danger of **reticulation** at that point.

The hardening properties of this intermediate bath are such that negatives treated in it are almost impervious to scratches. It accelerates final drying of the film by contracting the layer of gelatine to its minimum, thus expelling as much moisture as possible. The emulsion of a negative treated in this solution and the subsequent acid fixing bath shows a remarkably glazed surface which makes it almost difficult to distinguish the emulsion side from the back of the film. This glaze is proof not only of sufficient hardness of the emulsion and fineness of grain, but also of the absence of reticulation.

The Acid Hardening Fixing Bath. This is the final solution required for processing Leica films and its purpose is to dissolve the unexposed portions of the silver and thus render it insensitive to light. Another function of this fixing bath is to harden the emulsion.

While the packaged form of acid fixing powders which merely requires solution in a given quantity of water is quite satisfactory, far superior and consistently satisfactory results are obtained by the use of the newest formula offered by Eastman Kodak Company:

Acid Hardening Fixing Bath for Films
Formula E.K. F-5

	Avoirdupois	Metric
Water (at about 125° F. or 52° C.)...	20 ounces	600.0 cc
Hypo (pea crystals or rice crystals)..	8 ounces	240.0 grams
Sodium Sulphite, desiccated..........	½ ounce	15.0 grams
*Acetic Acid, 28% pure.............	1½ fl. ounces	47.0 cc
Boric Acid, crystals	¼ ounce	7.5 grams
Potassium Alum	½ ounce	15.0 grams
Cold water to make	32 ounces	1.0 liter

*To make 28% acetic acid from glacial acetic acid, dilute 3 parts of glacial acetic acid with 8 parts of water.

Directions for mixing:

Dissolve the Hypo in about one-half the required volume of water; then add the remaining chemicals in the order given, taking care that each chemical is dissolved before the next is added. Then dilute with water to the required volume.

The film should be left in this hypo bath for 10 minutes (temperature should be preferably the same as that of the developer), and it is frankly recommended to use the hypo for fixing of film once only, after which it may be collected in a separate bottle for fixing of paper. This may be considered by some as somewhat extravagant, but it should be worth while to know that this final step in processing some thirty negatives will insure their longevity, which greatly depends on the freshness and strength of the hypo.

For those who require larger quantities of acid fixing bath it is recommended that they keep a separate solution of straight Hypo and a separate Acid Hardener Stock Solution, mixing them in proper proportions just before using. This results in fresher solution when required:

Acid Hardener Stock Solution
Formula E.K. F-5a

	Avoirdupois	Metric
Water (at about 125° F. or 52° C.)...	20 ounces	600.0 cc
Sodium Sulphite, desiccated..........	2½ ounces	75.0 grams
Acetic Acid, 28% pure	7½ fl. ounces	235.0 cc
Boric Acid, crystals	1¼ ounces	37.5 grams
Potassium Alum	2½ ounces	75.0 grams
Cold water to make	32 ounces	1.0 liter

Dissolve chemicals in the order given, taking care that each chemical is dissolved before the next is added.

Add slowly one part of the cool Acid Hardener Stock Solution to four parts of cool 30% hypo solution (2½ pounds of hypo per gallon of water) while stirring the latter rapidly.

Washing the Film

After fixing, the film should be thoroughly washed to remove all traces of Hypo, otherwise the negatives may in time develop stains. Washing is best carried out while the film is still in the developing tank. A steady stream of water, not colder than 65° F. (18° C.) nor warmer than 70° F. (21°C.), should be permitted to run into the tank through the opening in its cover for not less than 20, preferably for 30 minutes. If it be important to wash the film quickly, it is suggested to proceed as follows: Fill the tank with water, agitate it for one-half to one minute, pour the water out. Repeat this operation six or seven times. The film ought to be free from Hypo at the end of this procedure, and ready for drying.

Drying the Film

The film should be carefully removed from the developing reel and hung from one end by means of a clip. It is best to suspend the film so that it will not come in contact with the wall or other objects while drying. With a Viscose Sponge or soft clean chamois, wetted and thoroughly squeezed out, the excess water should be wiped carefully off both sides of the film in one slow, gentle and uniform stroke for each side. A well hardened film should dry of its own accord in 20 to 30 minutes after being suspended. For quick drying an electric fan may be used, provided one is sure the fan will not direct a stream of dust onto the film. Dust particles hurled at the delicate gelatine surface will become imbedded in it beyond hope of removal. It is therefore preferable that the current of air strike the uncoated celluloid back side of the film.

Soaking a Film Before Development

Unless the exposed film is old and brittle it should not be soaked in water before development. There seems to be no advantage in presoaking a film to be developed. It would be just one unnecessary operation. The old contention in favor of such a procedure was that it prevented formation of air bells and enabled the developer to start work more quickly and uniformly by presoftening the emulsion. Air bells are successfully eliminated by agitating the developer as soon as it is poured into the tank; while the developer needs no presoftening of the emulsion to start its uniform action which is to continue for some twenty minutes anyhow.

It is one of the features of the technique offered here to develop a Leica film with the utmost simplicity and effectiveness, with complete elimination of all steps of doubtful value.

Step by Step Developing Procedure

To develop a roll of Leica film proceed as follows:

Step 1. In total darkness wind film onto the spool of the developing tank, emulsion side in (facing center of reel). To do so, do not pull the film out of the closed or partly opened magazine. Open the magazine, take the spool out and hold it in the palm of the hand while rewinding it onto the reel of the developing tank. Be sure to close tank carefully and securely before turning on light.

Step 2. Cool developer to exact temperature required for given developer. While cooling developer, prepare short-stop bath and the hypo. Short-stop bath should be about the temperature of the developer. Hypo not less than 65°F. (18°C.) or more than 70°F. (21°C.).

Step 3. Pour developer in steady stream into developing tank. Directly after filling tank, observe time on clock and start agitating developer. Agitate for about one minute, not vigorously but steadily to prevent formation of air bells. Agitate every three to five minutes thereafter.

Step 4. One-half minute before expiration of full time called for by developing formula, start pouring out developer from the tank (pour into original storing container, unless developer life is exhausted). Shake all developer carefully out of tank.

Step 5. Without rinsing, pour the short-stop bath into tank in a steady stream. Observe time on clock and start agitating for about one minute. Leave short-stop in tank for five minutes, agitating occasionally. Pour it off at expiration of time. The short-stop should be used once only.

Step 6. Pour in hypo without rinsing tank. Start agitating directly after tank is filled with hypo and continue every two or three minutes. Fresh hypo should remain in tank for 10 minutes. At the end of 10 minutes, pour off hypo. Hypo should not be used for fixing film more than twice (preferably once). It can then be used for fixing out papers.

Step 7. After pouring out hypo, fill the tank with running water. Adjust it to a temperature of between 65°F. (18°C.) and 70°F. (21°C). Water colder than 65°F. will not wash the film properly; warmer than 70°F. it is likely to soften the film. After filling tank with water, agitate it briefly but vigorously, pour out water and put tank under tap, letting the water run down in a steady stream for about twenty to thirty minutes.

Step 8. Remove film from tank. Hang it by film clips in a cool, dry, dust-free place and wipe off excess water gently from both surfaces of film by means of Viscose Sponge. The sponge should be wet, but thoroughly squeezed out. When wiping emulsion side only the gentlest pressure should be

exerted to prevent scratching. The celluloid side of the film should be dried thoroughly with slightly more pressure. Film will dry normally in twenty to thirty minutes, but it is best to let it hang for about three times the length of time it requires for the film to become concave with respect to the emulsion side.

Step 9. Roll film carefully, emulsion side in, and store it in a dry, dust-free, clean box. A small rubber band slipped over the roll will prevent film from scratching.

Step 10. It is best not to put the film into an enlarger for from six to twelve hours after it has dried out. Objectionable Newton rings will form if "green" film is placed in the enlarger.

Complete Procedure for REVERSAL of Agfa Superpan Reversible Film

Reversible Superpan should be handled in total darkness. It can, however, be desensitized in a 1:2000 Pinakryptol Green Solution for two minutes, and then handled in bright green light such as the Agfa #103 green safelight with a 25 W. bulb.

The reversal procedure is divided into six basic operations, which are interspersed with appropriate periods of washing in running water.

1. DEVELOPMENT OF THE NEGATIVE IMAGE

First Developer.

	Avoirdupois	Metric
Water (125° F. or 52° C.)	24 ounces	750.0 cc
Metol	30 grains	2.0 grams
Sodium Sulphite	1 ounce	30.0 grams
Hydroquinone	180 grains	12.0 grams
Potassium Bromide	120 grains	8.0 grams
Sodium Hydroxide	265 grains	18.0 grams
Potassium Sulphocyanate	75 grains	5.0 grams
Cold Water to make	32 ounces	1000.0 cc

Develop normally exposed film for 6 minutes at 65° F. or 18° C. with constant, though not too rapid agitation. Do not use this developer more than once for consistently good results.

Wash film in running water for 10 minutes.

The accuracy of the first development and the thoroughness of washing following it are the two most important steps in the entire procedure.

2. REVERSAL

Reversal Bath (Bleach)

Water to make	32 ounces	1000.0 cc
Potassium Bichromate	75 grains	5.0 grams
Sulphuric Acid (Concentrated)	1.3 drams	5.0 cc

Add Sulphuric acid last, pouring it slowly while stirring.
Agfacolor Plate Reversing Salts put up in tubes, ready to be dissolved in 18 ounces of water may be substituted for above reversal bath.

After the film has remained in the Reversal Bath for at least 2 minutes, white light may be turned on in the darkroom and the remainder of the procedure may be conducted in white light.

Carry on reversal until both the negative image and the anti-halation undercoating are dissolved leaving only the undeveloped silver haloid. This requires about 5 minutes.

Wash film in running water for 5 minutes.

3. CLEARING

Clearing Bath

Water to make	32 ounces	1000.0 cc
Sodium Sulphite (dessicated)	1 2/3 ounces	50.0 grams

Clear in above solution for 5 minutes. Yellow stain is gradually removed and the emulsion assumes a clear white color.

Wash in running water for 2 minutes.

4. RE-EXPOSURE TO LIGHT

Thoroughly expose film to white light of a 200 watt bulb or of a Photoflood bulb (either bulb should be placed in a reflector). Hold film about 6 feet away from light, rotating it so that its entire surface, both front and back, is thoroughly exposed. Exposure required: 2-3 minutes. Direct sunlight should not be used. Film should not be held too closely to light source to avoid injury to emulsion from heat.

5. REDEVELOPMENT

Second Developer

Water (at 125° F. or 52° C.)	24 ounces	750.0 cc
Metol	30 grains	2.0 grams
Sodium Sulphite (dessicated)	370 grains	25.0 grams
Hydroquinone	60 grains	4.0 grams
Sodium Carbonate (monohydrated)	295 grains	20.0 grams
Potassium Bromide	30 grains	2.0 grams
Cold water to make	32 ounces	1000.0 cc

Develop until image has become thoroughly blackened, which requires about 5 minutes.

Rinse in running water for 3-5 minutes.

6. FIXING

Fix for five minutes in regular acid hardening fixing hypo bath (p. 123).
Wash in running water for 10-15 minutes.
Wipe off surface water gently with the aid of viscose sponge.
Hang up film to dry.

All solutions and the running water should be maintained throughout the procedure at 65° F. or 18° C. Utmost cleanliness is required for successful results. Avoid contamination of solutions through carrying one into another.

General Suggestions

Utmost cleanliness should be observed throughout processing of Leica negatives.

Use only the best and purest chemicals, and once a brand is adopted continue to use it for uniform results.

Observe greatest accuracy in weighing and measuring chemicals.

Never permit fingers to come in contact with emulsion side of film either before or after developing.

Never handle film except by its edges.

If film becomes soiled, wipe it carefully with a soft chamois skin dipped in a suitable film cleaner (see page 130).

Apron of Correx tank should be removed when not in use, and kept suspended by one or both its ends.

Films should be kept as far away as possible from heat, radiators, hot water pipes, etc. It should be remembered that most of our negative material is nitrate stock and highly inflammable. Therefore films should be kept in a well ventilated cool dark place, away from open flame.

Developing and handling of Leica negatives should not be turned into an obsession, but should be considered as only one of the factors which contributes towards the final picture.

Reticulation

Reticulation is a peculiar phenomenon occurring on films, and in the case of Leica films it may actually ruin an otherwise perfect negative. It is due to local strains in the gelatine which may be caused by a sudden change in temperature of solutions, or atmospheric conditions. It occurs in different degrees, from an extremely mild form barely distinguishable by the eye, to a very severe form. Reticulation looks like miniature elephant skin shrivelled into a labyrinth-like pattern. In its severest form it produces actual tiny cracks in the emulsion; the accompanying illustration shows this condition.

Reticulation can happen at any point during processing of film, including pre-soaking, during development, or at the point of change from developer to hypo. It can even occur while the finished film is drying.

To minimize the danger of reticulation, the pre-soaking of the film, and its washing between solutions should be entirely eliminated. **The use of the short-stop as an intermediate bath between the developer and hypo cannot be recommended strongly enough.** The chrome alum and sodium bisulphite short-stop has a beneficial effect upon the film by its gentle hardening and slightly acid action as a transition from the alkaline developer to the highly acid hardening fixing bath. It is believed that the short-stop carried over in small quantities into the hypo bath corrects the acidity of the latter to the point where it will not cause reticulation.

Fig. 87 Reticulation, mild
(Anonymous!)

Fig. 88 Reticulation, acute—
cracks in emulsion
(Anonymous!)

Newton Rings

Another source of considerable annoyance are the so-called Newton rings. These are irregular spots of all colors of the spectrum appearing on the surface of the enlarging paper while the negative is in the enlarger for printing. In appearance these Newton rings suggest those charac-

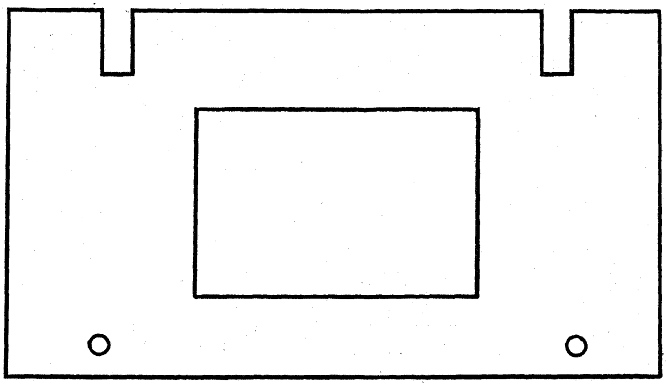


Fig. 89 Masking plate for elimination of Newton Rings, actual size for tracing

teristic, rather pretty, patterns which oil forms on water. While pretty to look at, Newton rings are a decided nuisance for they will ruin any print, and are hard to eliminate.

They occur particularly on "green" film, that is, film that has just been dried but still contains moisture. For this reason it is recommended that films not be put into the enlarger for six to twelve hours after drying.

Newton rings are actually caused by the condenser of the enlarger not being in perfect contact with the entire back of the film, but merely touching it at several points, indicating that the film is not in a true plane.

Of most remedies suggested for correction of this annoying condition the one providing a special mask or spacer, as shown in the cut which is a full size tracing, is the most practical. This masking plate can be made from a thoroughly fogged, developed and fixed out piece of cut film, with the aid of a sharp razor blade. The regular masking negative carrying plate is taken out of the enlarger, the film placed over it as usual emulsion side down, and the special mask placed over the negative; the entire assembly is then slipped into the enlarger and from this point the procedure is carried on as usual.

Film Cleaner

Film that is dusty, dirty, shows finger marks, lint, etc., should be carefully cleaned before placing it in the enlarger.

An excellent all-around film cleaner is easily prepared as follows:

Ethyl Alcohol (pure grain alcohol)...	**85%**	**(or parts)**
Methyl Alcohol (wood alcohol)......	**10%**	**(or parts)**
Strong Ammonia	**5%**	**(or parts)**

This cleaner is not "dry", as is carbon tetrachloride and similar cleaners. Because this cleaner is "wet", it does not charge the film electrically, thus leaving it without the usual tendency to attract lint and dust from the air. This cleaner should be applied to both surfaces of the film with a clean, lintless fine linen cloth, soft chamois or lens tissue.

Reducing or Intensifying Leica Negatives

These two processes are, to say the least, dangerous for miniature camera work, and their use is definitely discouraged. Either of these processes increases the grain considerably and destroys definition. However, for those who wish to save a valuable negative, the two formulas most suitable for miniature camera work are offered:

E.K. FORMULA R-5—PROPORTIONAL REDUCER

Stock Solution A

	Avoirdupois	Metric
Water	**32 ounces**	**1.0 liter**
Potassium Permanganate	**4 grains**	**0.3 gram**
Sulphuric Acid (10% solution)....	**½ ounce**	**16.0 cc.**

Stock Solution B

Water	**96 ounces**	**3.0 liters**
Ammonium Persulphate............	**3 ounces**	**90.0 grams**

For use, take one part of A to three parts of B. When sufficient reduction is secured the negative should be cleared in a 1% solution of sodium bisulphite. Wash the negative thoroughly before drying.

E.K. FORMULA IN-5—SILVER INTENSIFIER

For 35mm Negative and Positive Films

The following formula is the only intensifier known that will not change the color of the image on positive film on projection. It gives proportional intensification and is easily controlled by varying the time of treatment. The formula is equally suitable for positive and negative film.

*Stock Solution No. 1

	Avoirdupois	Metric
Silver Nitrate	2 ounces	60.0 grams
Distilled water to make	32 ounces	1.0 liter

* Store in a brown bottle.

Stock Solution No. 2

Sodium Sulphite, desiccated	2 ounces	60.0 grams
Water to make	32 ounces	1.0 liter

Stock Solution No. 3

Hypo	3½ ounces	105.0 grams
Water to make	32 ounces	1.0 liter

Stock Solution No. 4

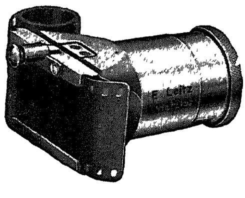
Sodium Sulphite, desiccated	½ ounce	15.0 grams
Metol	350 grains	24.0 grams
Water to make	96 ounces	3.0 liters

Prepare the intensifier solution for use as follows: Slowly add 1 part of solution No. 2 to 1 part of solution No. 1, shaking or stirring to obtain thorough mixing. The white precipitate which appears is then dissolved by the addition of 1 part of solution No. 3. Allow the resulting solution to stand a few minutes until clear. Then add, with stirring, 3 parts of solution No. 4. The intensifier is then ready for use and the film should be treated immediately. The degree of intensification obtained depends upon the time of treatment which should not exceed 25 minutes. After intensification, immerse the film for 2 minutes with agitation in a plain 30% hypo solution. Then wash thoroughly.

Storage and Preservation of Films

This matter is again a question of personal preference. The writer knows of as many storing and filing systems as he knows Leica workers. There are transparent cellophane envelopes in book or box form holding strips of from three to eight negatives. There are books with flaps of transparent paper and books with pockets. There are filing cabinets and chests of endless variety.

Personally, the writer prefers to preserve, store and file Leica negatives in uncut lengths, in rolls firmly but not tightly wound. A small rubber band (about ½″ diameter) is slipped around the roll before placing it in a steel box divided into small sections of twenty-five to a box. Each roll is given a number and a brief description of the entire roll marked under the corresponding number on the inside lid of the box. Each box is marked with an alphabet number and a record kept in a loose leaf scrap book into which contact prints from every roll are pasted.



The Negative Viewer and Marker is Convenient for Examining Completed Films

Fig. 90 Direct Enlargement

Fig. 91 Contact Print from an 8 x 10 Reversal Negative Retouched

MAKING OF ENLARGED NEGATIVES: THREE METHODS

JOHN N. HARMAN, JR. **CHAPTER 5**

Probably everyone who has ever made a Leica shot and "blown it up" to a good sized enlargement has wished for an opportunity to do a bit of retouching on minor parts of the negative. But a microscopic eye is needed for work as exacting as this and retouching and spotting have as a result been relegated to the final print.

Many a cynical megacamist has seized this apparent fault as the clinching point in his arguments against "postage stamp" negatives. And this with little reason, for there are **three ways** by which Leica photographs may be conveniently put into the form of enlarged negatives for retouching before the final print or enlargement is made.

Retouching, however, is not the only advantage offered by the use of enlarged negatives—for they come in handy in many ways. Whenever several enlargements requiring dodging or projection control are desired to be made identical with one another, the use of an enlarged negative not only simplifies the procedure and cuts the over-all working time, but it insures the uniformity of the final prints. All the dodging and retouching may, for example, be done upon one master enlarged negative of from 4 x 5 to 8 x 10 inches in size, and all prints of any size may be contact printed, enlarged, or reduced from this with unvarying results. The contrast of originals that are too dense or too flat may also be improved in the preparation of the enlarged negative. Furthermore, enlarged negatives offer an excellent medium for the combination of parts of different negatives when, as is sometimes the case, the final print is built of several separate images.

There are three methods which may be used to obtain good enlarged negatives without excessive time or trouble in processing.

The first involves the use of a new and singular photographic material, "**Direct Copy Film**". This unusual film produces a negative directly from a negative—although it is processed in a manner no different than that regularly used for chloride printing paper.

The second method is based upon the use of a **reversible film** for the original exposure in the Leica. Upon special development, this reversible film produces a positive (normally used for projection purposes) which is then enlarged on a process or commercial film to give the enlarged negative.

The third method embraces the preparation of an **intermediate film positive** from which the enlarged negative is made. This is naturally the longest process in point of time but it is well known and will do the trick admirably if the special films required for either of the first two methods are not obtained.

Direct Copy Film is a new material which is being manufactured by the Agfa Ansco Corporation of Binghamton, N. Y. The emulsion of this remarkable film has properties by means of which it can produce in one single exposure and development a negative from a negative (or for that matter, a positive from a positive). The emulsion of the film is treated during manufacture so that when developed without any exposure whatsoever, a maximum density of opaque silver is produced. However, for every increasing amount of exposure the film shows a corresponding increase in transparency after development. Thus, light parts of an original are duplicated by transparent portions of the copy film and shadow regions of the original are represented with equal accuracy. Aside from this unusual characteristic the emulsion of Direct Copy Film resembles a chloride printing paper in color sensitivity, required exposure, and general handling and processing in the darkroom. Because Direct Copy Film has an extremely fine-grained emulsion no additional graininess is produced in the final enlargement by this method.

Because of its peculiar properties, Direct Copy Film makes the preparation of enlarged negatives a rapid and simple procedure. The only operations requiring special mention are those of exposure and development. Fixation and washing are done in the conventional manner.

Since Direct Copy Film has approximately the same speed as the standard soft grades of contact printing paper, Leica negatives may be enlarged onto it without unduly long exposures when a photoflood bulb is used in the enlarger. A small strip of chloride printing paper such as Convira may be used in making a preliminary test exposure, and the correct printing time determined from the test exposure. The piece of Direct Copy Film should be mounted on the enlarging easel with the emulsion side up. The Leica negative to be enlarged should be inserted in the enlarger, not in the usual way, but with the *emulsion side facing upward* instead of downward. This will give a reversed (from left to right) image on the easel and a correct image in the final print. The density of the enlarged negative should be controlled by adjusting the exposure and not by modification of the developing time. Thin copy negatives indicate over-exposure, while an enlarged negative that is too dense is the result of under-exposure. Amber or bright orange light may be used in the darkroom.

Development of the enlarged negative on Direct Copy Film can be carried out in any soft-working film developer, but the two following formulas are recommended for best results.

For Normal Gradation on Direct Copy Film

	Avoirdupois	Metric
Water to make	32 ounces	1.0 liter
Metol	23 grains	1.5 grams
Sodium Sulphite, anhydrous	2 oz. 290 gr.	80.0 grams
Hydroquinone	45 grains	3.0 grams
Borax	45 grains	3.0 grams
Potassium Bromide	8 grains	0.5 grams

Use without dilution. Develop 12 to 20 minutes at 5° F. (18° C.).

For Moderate Brilliance on Direct Copy Film

	Avoirdupois	Metric
Water (lukewarm)	32 ounces	1.0 liter
Metol	90 grains	6.0 grams
Sodium Sulphite, anhydrous	6 ounces	180.0 grams
Sodium Bisulphite	60 grains	4.0 grams
Hydroquinone	180 grains	12.0 grams
Sodium Carbonate, monohydrated	360 grains	24.0 grams
Potassium Bromide	48 grains	3.2 grams
Add cold water to make	1 gal.	4.0 liters

Use without dilution. Develop 8 to 10 minutes at 65°F. (18° C.).

As mentioned above, variations in results should be controlled more by adjustment of exposure rather than by modification of developing time. Best results will be obtained by keeping within the times recommended for each developer. Stains will be avoided by the use of a conventional acid short stop bath between development and fixation.

Enlarged Negatives from Reversible Film Originals

The second method of preparing enlarged negatives relies upon the use of a **reversible film** in the Leica for the original exposure. This film is developed by a reversal process to a positive, usually for projection purposes. A film of this kind, prepared especially for the Leica, is made by the Agfa Ansco Corporation of Binghamton, N. Y., and is sold under the name of Superpan Reversible. It is a high speed, panchromatic material which may be compared to the supersensitive type in group 1 (see pages 101, 104). Because it is a reversal film it gives positives which have an exceptional fineness of grain—a noteworthy point for all miniature-camera work. The positive resulting from the processing of the Superpan Reversible Film can be easily enlarged onto a piece of Commercial, Commercial Ortho or Process Cut Film and developed in a standard negative film developer. The exposure required by Process Film will be about the same as that needed for the faster grades of Bromide enlarging paper, while Commercial and Commercial Ortho Film will require about one-tenth as much exposure.

The processing of the reversible film original will be done at a nominal charge by the film manufacturer but it can be carried out satisfactorily in about two hours by the procedure outlined in detail on page 126 of this volume.

Enlarged Negatives by the Positive-Negative Process

The third method by which enlarged negatives may be made from Leica originals requires the preparation of an **intermediate positive film.** This may be made, of course, by contact printing onto 35mm. positive film stock and proceeding as with the reversible film positive. However, greater convenience is undoubtedly afforded by the preparation of the intermediate film positive in an enlarged form. This is easily done by enlarging the original Leica negative onto a sheet of Process or Commercial Film instead of the usual bromide paper. Development can be carried out in a conventional negative film developer such as the following:

	Avoirdupois	Metric
Water (lukewarm)	**32 ounces**	**1 liter**
Metol	**90 grains**	**6 grams**
Sodium Sulphite, anhydrous	**6 ounces**	**180 grams**
Sodium Bisulphite	**60 grains**	**4 grams**
Hydroquinone	**180 grains**	**12 grams**
Sodium Carbonate, monohydrated	**360 grains**	**24 grams**
Potassium Bromide	**48 grains**	**3.2 grams**
Add cold water to make	**1 gal.**	**4 liters**

TRAY DEVELOPMENT: Use full strength. Normal development time, 5 to 7 minutes at 65°F.

TANK DEVELOPMENT: Dilute one part above developer to one part water. Normal development time, 12 to 14 minutes at 65°F.

This enlarged positive film when fixed, washed and dried can then be contact printed or enlarged onto another piece of Process or Commercial Film to produce the final enlarged negative. Retouching and dodging can, of course, be done at either of the two intermediate steps—intermediate positive, or final enlarged negative. If Process Film is used for both intermediate positive and final master negative, developing time should be decreased to avoid results of excessive contrast.

EDITOR'S NOTE: For finer gradation, softness and minute details expected of pictorial work, it may be found that substitution of the positive Process or Commercial film, suggested by the author, by a softer film may be more effective. Reference is made to the type of film offered by orthochromatic emulsions such as Eastman Portrait or Safety Ortho films, Agfa Plenachrome or Defender Pentagon. These films are more sensitive to light in general and a shorter exposure is required than for the positive film. The Safelight, of course, would need to be changed from yellow to ruby, according to recommendations contained in each package of film. Otherwise, the procedure is not different from that outlined by the author.

YOUR OWN LEICA DARKROOM

WILLARD D. MORGAN **CHAPTER 6**

A photographic darkroom can be the source of many enjoyable hours. Here is a place where you can try out some of those new photographic ideas of yours, make your exhibition enlargements, try out the latest developing formula, make photo-montages, lantern slides, develop color film, and experiment with various enlarging papers. As you complete your darkroom it will quickly become the meeting place for your friends who have similar interests. After a hectic day at the office or some other occupation the evening hours in your darkroom will be one of the most enjoyable relaxations you can experience.

Make the darkroom a model of convenience, cleanliness, and neatness. If you cannot find space for a separate room for your work don't worry but fix up the kitchen sink for your developing and enlarging equipment. Dark shades over the windows will exclude all light, and the darkroom safety light may be easily installed over the sink. If the kitchen is not convenient explore the bathroom and confiscate one corner for your equipment. A wide board over the bathtub will hold several trays, while the bathtub and sink may be used for washing the prints or films. There are thousands of "bathtub finishers" located in every section of the country who are doing excellent photographic work. The writer belonged to this fraternity of "bathtub finishers" for many years before he had an opportunity to enjoy the thrills of having a separate darkroom completely equipped for his work.

If you happen to be living in a small apartment and wonder how you can solve the darkroom situation try converting the kitchenette into a darkroomette. Such a transformation has been cleverly done by John T. Moss, Jr. of New York. The accompanying photograph will give a complete plan of Mr. Moss's darkroomette. Note that the folding doors may be closed or opened as required. The refrigerator can be used for keeping solutions cool, or it may be a source of ice cubes when required. It is surprising how small a space

can be utilized for doing all one's developing and enlarging work, so don't let the space problem worry you when you set up a place to do your finishing work. J. Harlan Davis of Mt. Vernon, Ohio has solved his space problem by constructing a "folding darkroom" right in his library. He has constructed a wall cabinet which holds all his equipment, and the door swings down to make the work table.

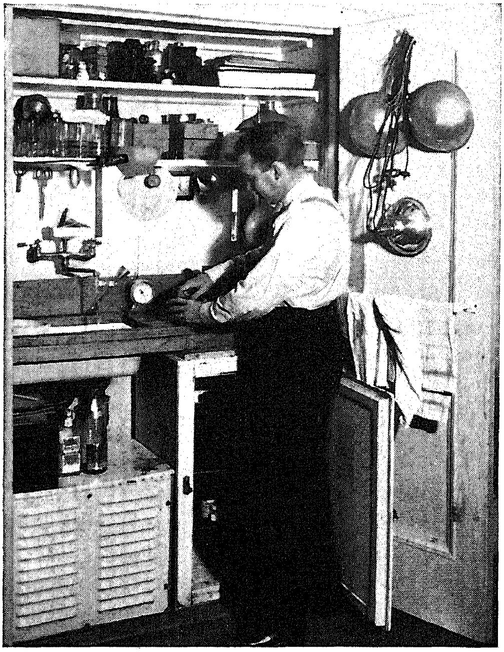


Fig. 92 "Darkroomette" of John T. Moss, Jr., utilizing facilities of the modern kitchenette

A Model Darkroom

In order that we may obtain a complete picture of what an amateur darkroom should look like let's take the model darkroom recently constructed by Lee Parsons Davis of New Rochelle, N. Y. The accompanying photographs and drawings will give you complete information, even better than any long detailed descriptions. Mr. Parsons based his plans upon a similar darkroom constructed by Clifford H. Beegle of Beaver Falls, Pa.

The inside dimensions of Mr. Parsons' darkroom are seven feet by six feet. Although this space may at first seem small it is surprising how much room there is to work and also how much space there is for storing equipment and supplies. The secret of this space utilization is that there are many storage drawers, and several shelves for chemical storage. Space has been made for print drying racks,

ferrotype tins, and a large sink five feet long by sixteen inches wide and one foot deep. The sink is constructed of California white pine $1\frac{1}{4}$ inches thick. The side and end boards are $12\frac{1}{2}$ inches wide, and the bottom is one wide board. These boards were grooved to fit at a planing mill, and set together without glue or nails, then bolted on the ends and bottom.

There are three faucets over the sink, two of which are combination faucets which permit the proper temperature regulation of the water. One of the faucets has a small under valve which permits an outlet for tray washing of prints as shown in the accompanying illustration. A removable drainboard for the sink provides for additional working space when required. The 11 by 14 inch developing trays will fit across the sink while the space below can be used for a larger washing tray. Plenty of electrical connections, safety lights, as well as the regular white lights are provided.

Finally, and one of the most important points to consider in the darkroom is the ventilation. A fresh air inlet has been provided for through the door of the darkroom, while the foul air is sucked out through a light-tight duct by an electric fan. This permits constant circulation of air, and when two or three people are working in the darkroom at one time there is always plenty of good clean air.

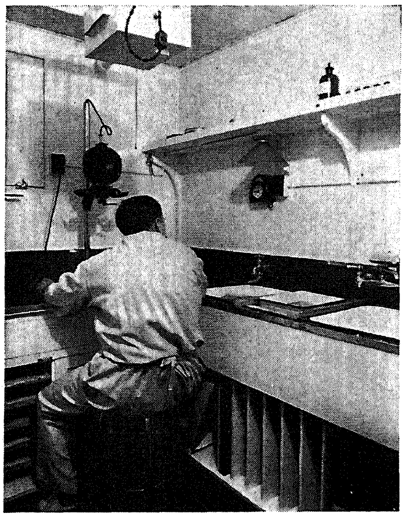


Fig. 93 Interior of photographic laboratory of Lee Parsons Davis.

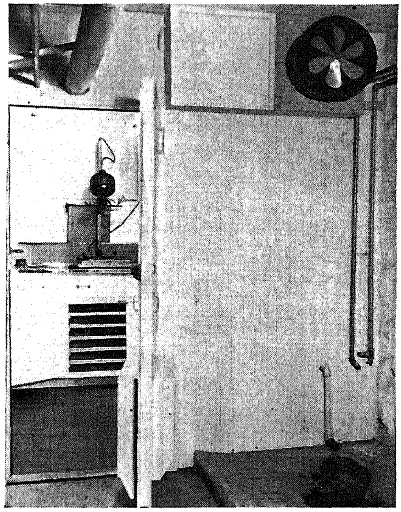


Fig. 94 Outside of Mr. Davis' photographic laboratory showing position of exhaust fan.
Note light trap ventilator on door.

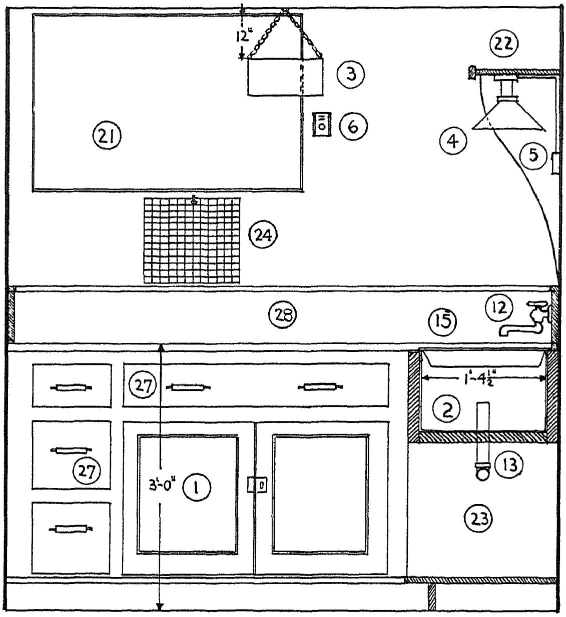


Fig. 95 Elevation facing work bench showing enlarging table, cabinets and cross-section of sink

Key to drawings (figures 95, 96, 97):

No. 1 Work bench and cabinet for print drying racks
No. 2 Sink—lead lined
No. 3 Wratten safe light, series No. 3, 40-watt Mazda bulb
No. 4 Safe lights
No. 5 Electric convenience outlets
No. 6 Electric outlet for enlarger
No. 7 Electric bright light
No. 8 Electric exhaust fan
No. 9 Fresh air inlet (light trap)
No. 10 Foul air discharge duct
No. 11 Cold water faucet
No. 12 Combination hot and cold water faucet
No. 13 Variable overflow drain pipe
No. 14 Removable drain board
No. 15 Sliding enameled developing trays
No. 16 Towel rack
No. 17 Light-tight door gasket
No. 18 Air thermometer
No. 19 Coat hook
No. 20 Stool
No. 21 Light-tight blind for exterior window
No. 22 Storage shelf for chemicals, etc.
No. 23 Storage space for solutions
No. 24 Trimming board and cutter
No. 25 Tray storage racks
No. 26 Storage space
No. 27 Equipment and supply drawers—full depth of work bench
No. 28 Bench top and back board covered with acid and alkali proof Micarta 1/16" thick, with chromium trim
No. 29 Foul air outlet grille
No. 30 Proposed recessed cabinet for books and film storage

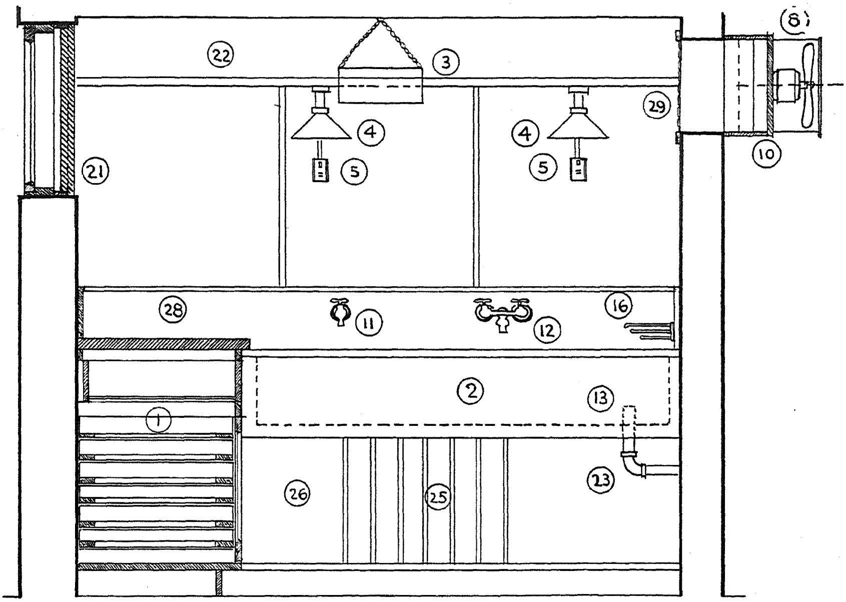


Fig. 96 Elevation showing sink, exhaust fan, safe lights, drying racks, etc.

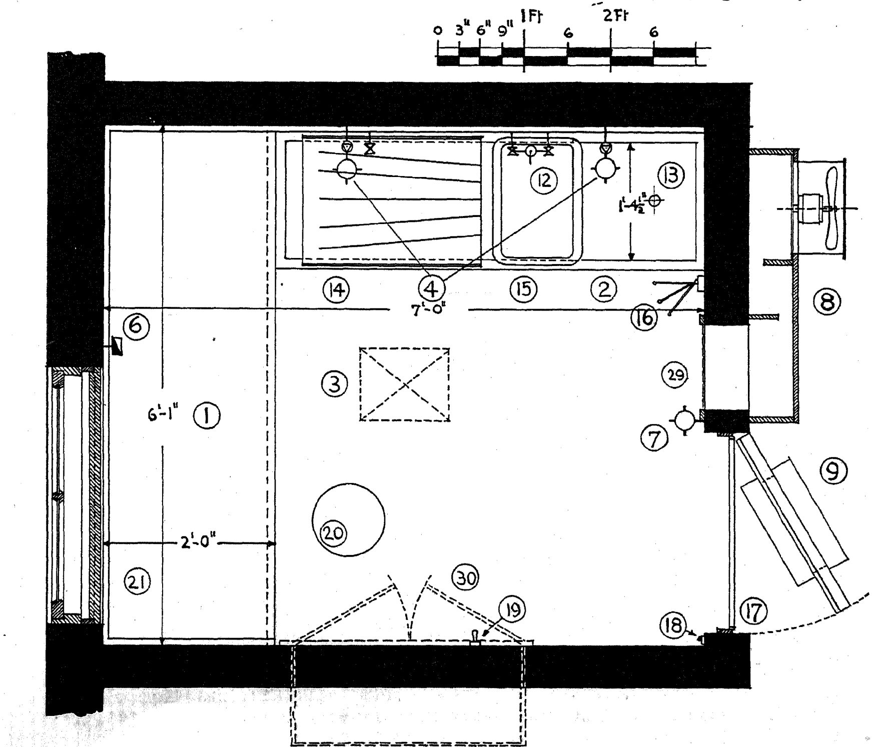


Fig. 97 Plan of Lee Parsons Davis' model darkroom.

Stocking the Complete Laboratory

Naturally one's darkroom equipment and supplies will be determined by individual tastes and requirements. Here is a list to consider when stocking your laboratory with everything but the "kitchen stove".

Developing tanks for film . . . developing trays for paper enlargements . . . enlarging equipment . . . film and glass slide contact printers . . . illuminating control rheostat for use with photoflood bulb in enlarger . . . paper cutter . . . safety lights for paper and films . . . chemicals and chemical weighing scale . . . electric agitator for film developing tank . . . thermometer . . . cotton and viscose sponges . . . supply of bottles for keeping solutions . . . supply of beakers and graduates for mixing and measuring solutions . . . small electric stove for heating solutions . . . metal clips for hanging film to dry . . . developing glass drum for color films or reversing other films . . . supply of enlarging paper . . . filing boxes for **negatives which must be kept free from dust at all times** . . . and finally a small corkboard mounted on the wall for tacking up formulas and special data which is often referred to such as weight conversion tables, developing times at various temperatures, etc.

A Two Room Laboratory

Now let's study still another darkroom or laboratory which is a little more elaborate and has the double room feature with a small separate nook for the chemical mixing department. This darkroom was designed by Clarence Slifer of Hollywood, California and described in the August 1934 issue of the American Cinematographer. Mr. Slifer describes his laboratory as follows:

In keeping with the progressiveness that is so apparent in Miniature Photography, herewith is presented a plan of a model laboratory. This room in which photographic processing is carried on, is not called a darkroom, simply because that word is a misnomer. It is not dark, for at all times, with the exceptions of when loading magazines or developing tanks, there is an abundance of light: properly filtered light for printing and daylight for other operations.

Removed is the stigma that the word darkroom has implied. This model laboratory is not a poorly ventilated closet, under the cellar stairs, but is a room planned for comfort, convenience, and practicability. All of which are conducive to better photographic work and the full enjoyment of miniature photography.

From the plan, it will be noticed the room is divided into two main divisions; the laboratory proper and the study. The laboratory, to take care of all photographic work from glossy prints to the advanced pictorial processes. The study, to serve as a place for working out photographic problems or as a place where you may argue with friends about the gammas, the paraphenylenes, and the reticulations of photography, without having your sanity questioned by other members of the household or being relegated to that esteemed position now held by butterfly-chasing professors.

The essential features of the model laboratory are:

1. A shallow wooden sink provided with removable slats for tray supports. Its six-foot length easily handles three trays up to 16"x20" in

size. Swing faucets practically "cover" the entire sink. Above the sink are shelves for stock solutions, etc. Below the sink, are racks for trays, box for waste and space for miscellaneous equipment. In the wall, above the right end or the sink, is a light-tight ventilator. This ventilator withdraws all hypo or chemical fumes arising from developing or toning prints. Also at this end of the sink, is a light fixture containing a day light bulb. The light from this fixture is concentrated down upon the hypo or toning tray, and is actuated by a foot switch. This permits examining prints for tone or contrast without drying the hands. The safe-light used for observing the developing of prints, has two degrees of brilliance: dim and bright. The bright light is controlled by a foot switch and is used only for limited periods of print examination. For cleanliness, liquid soap and paper towels are a part of the sink equipment.

2. A film developing bench especially equipped for miniature negative developing. The importance of agitation in small film processing is recognized by the inclusion of an electric agitation machine in the laboratory equipment. Also provided is a negative viewing box (a white light behind opal glass). Affixed to the glass are gamma films of different densities for use in judging the progress of development. An ice chest for cooling solutions may be placed under the bench.
3. A print washing machine preferably of the Kodak rotating type. This provides a quick, efficient, and thorough means of washing prints with little handling.

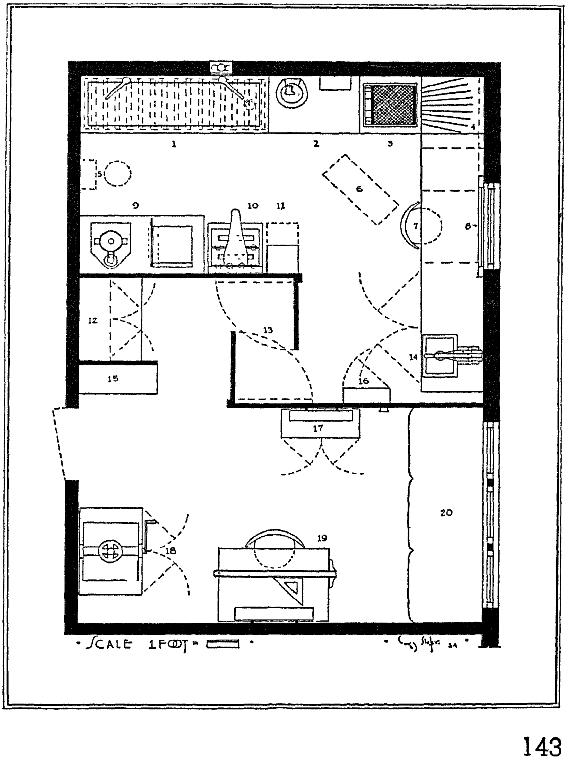


Fig. 98 Plan of two room laboratory designed by Clarence Slifer

4. A drain-board for prints after they have been removed from the washer.
5. A holder for paper towels and a shelf for the radio (the companion in the laboratory). Indicated here, is a stool, as much printing may be carried on while seated.
6. A double, indirect safe-light for general room illumination.
7. A long cabinet of an exaggerated desk-like appearance, with shelf or cabinet space above. Underneath the left end is a set of drawers for keeping Bromoil brushes, paints, and other materials. Space is provided for leg-room when seated before the portion of the bench at the window. Here is an ideal place to work upon Bromoils, spot or color prints, retouch enlarged negatives, etc. Underneath the right end of the bench, are frames with stretched cloth-net for laying prints upon, to dry.
8. A sliding light-tight shutter for the window.
9. A cabinet-bench for a miniature negative enlarger of the Leitz Focomat or Valoy type. The enlarger is controlled by a foot switch, thus leaving both hands free for "dodging". This freedom is further enhanced by the use of a metronome for timing prints audibly, during difficult exposures. At other times a large electric clock serves the purpose. On the wall, back of the enlarger, is an Illumination Control Rheostat for use with a Photo-flood lamp, when enlarging upon chloride (contact) papers. Light-tight drawers are in the cabinet, for the storage of photographic paper. To the left of the enlarger, is a print trimmer. To facilitate print trimming, the edge of the print trimmer is illuminated by a light, sunk in the cabinet.
10. An 11"x14" contact printing machine, which is used for printing enlarged negatives and also strips of Leica film, for proofs.
11. A film loading and negative filing desk.
12 Chemical closet, for chemical storage and mixing. In the lower part of the cabinet, is a bin for hypo crystals and a fixture for supporting a five-gallon bottle of distilled water. Due to its location, chemical dust in the laboratory is eliminated.
13. Light-tight entry to the laboratory, affording easy access and ventilation. The partitions fold back, whenever it is desirable.
14. Dry mounting press, for mounting photographs.
15. Bookshelves, for those indispensable photographic books and magazines.
16. A light-tight film drying cabinet, six feet high. Air is drawn in, through silk screens, from the study, thus minimizing the nuisance of dust. The cabinet may also be used for drying hyper-sensitized film.
17. A cabinet for camera equipment. Upon this cabinet is an easel for holding prints to be admired or glared at. A conventional, picture-illumination fixture is used for light.
18. A Bromoil transfer press and a cabinet for card stock, etc.
19. Desk-like drawing table with long fixture for diffused light above.
20. Long, comfortable window seat.

The plan of this model laboratory is based upon the knowledge gainec from a number of years' experience in many photographic "darkrooms" So turn back and study the plan over, for perhaps you may find some idea: for your Ideal Laboratory for Leica Photography.

ENLARGING AND CONTACT PRINTING

WILLARD D. MORGAN

CHAPTER 7

After the Leica negative has been made the next step is to have it printed, either by contact upon paper or film, or by direct enlargement. The choice in printing really depends upon our individual requirements. Some prefer to make paper contact prints of all their negatives for reference purposes, while others would rather make enlargements direct. In order to reproduce the finest qualities in a Leica negative it is necessary to either make positive film or glass slides for projection upon a screen or to make enlargements upon some of the various printing papers now available. We will discuss the methods for enlarging first.

Making positive prints from Leica negatives offers many distinct advantages:

1. There is the choice of many fine enlarging papers which may be secured in various surfaces and grades of contrast. The chapter on enlarging papers will give complete information on this point.
2. Enlargements may be shaded or dodged during the printing in order to emphasize or hold back any portion of the picture. For example an overexposed sky may be printed longer than the underexposed foreground.
3. The unattractive or disturbing parts of a negative may easily be omitted to improve the composition of the finished picture.
4. The enlarging easel and the enlarger housing may be tilted for correcting the perspective in a picture. This feature is especially valuable when enlarging architectural pictures which have been taken close to the subject with the camera pointed slightly upward or at a sharp angle.
5. The slow printing contact or chloride papers can be used when a photoflood bulb is placed in the enlarger.
6. Enlarging screens, gauze, special effect filters, and other accessories may also be used with the enlarger for securing special effects in enlargements to please the various individual tastes.
7. The Leica enlargement of post card size or larger produces a picture which can easily be studied by anyone.

Selecting the Enlarging Equipment

Before the actual enlargements can be made it is necessary to select the proper enlarging equipment. A good enlarger will last a lifetime. By actually enlarging your own negatives you will learn

many things about your pictures. You will have a keener sense of the proper composition, a better judging of correct exposures, improper focusing will show up instantly, and even when you are making your original picture you may have in mind certain enlarging papers for the subjects taken. So in order to gain these advantages let's become more familiar with the actual working equipment available.

The Valoy Enlarger

The present Valoy enlarger is actually the outgrowth of the former Filoy and Fylab enlargers. While these latter enlargers are still producing excellent enlargements for those who still own them, the present Valoy enlarger was constructed to give a few additional conveniences in handling the negatives. This enlarger may be described as follows:

1. Baseboard, 15½ x 18 inches in size, for holding the paper easel and the metal upright bar which supports the enlarger lamp housing.
2. Upright metal bar, 1¼ inches in diameter, available in 80cm and 120cm lengths. Electric connecting wire passes through the center of the metal upright. At the base of the upright is a grounding connection marked "E" for attaching a ground wire if desired.
3. Lamp housing supported by an extension arm which clamps around the metal upright bar.
4. Adjustable lamp base for centering and otherwise moving the enlarging bulb into the best position to give an even illumination over the entire negative area.
5. Removable condenser with adjusting lever for clamping Leica negative into position for enlarging.
6. Space for accommodating various masks for single frame, Leica double frame, 3 x 4cm, and 4 x 4cm negatives. Hinged glass negative holders also available for use with single negatives which have been cut from the regular rolls.
7. Focusing lens mount will accommodate the various Leica lenses. The 50mm lenses are recommended for use in this enlarger.
8. The condenser may be removed for cleaning by turning the clamping ring inside of the lamp housing, removing the spring, and then lifting out the condenser. It is a good plan to remove this condenser frequently and carefully clean the surface with lens tissue or a clean linen.
9. An intermediate ventilating ring is recommended for use with the Valoy enlarger when a photoflood bulb is used.
10. A small snap switch is attached to the baseboard of the enlarger for making the exposures.

The Focomat Enlarger

The Focomat Enlarger is very similar to the Valoy Enlarger with the exception of the automatic focusing features. The lamp housing, movable condenser and method of inserting the film in the Focomat Enlarger is just the same as in the Valoy Enlarger. The differences may be mentioned as follows:

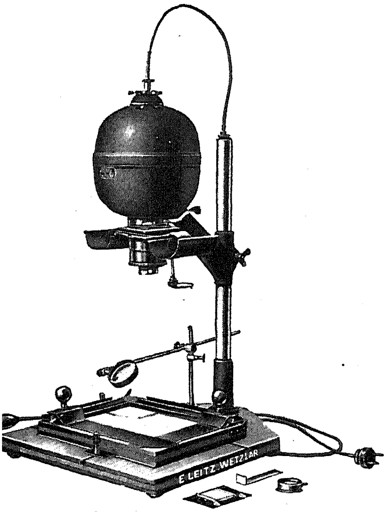


Fig. 99 Valoy Enlarger, complete with easel, magnifier, orange filter and negative masking carrier plate

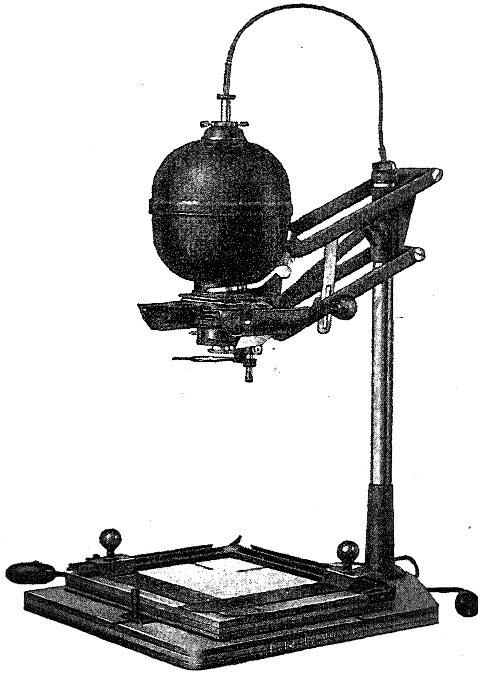


Fig. 100 Focomat Enlarger, complete with easel and orange filter

1. As shown in the illustration the Focomat Enlarger has two extension arms which attach the lamp housing to the upright pillar. The upper arm holds the lamp housing, while the lower arm likewise holds the lamp housing in a vertical position and at the same time makes the changes in the focus of the lens.
2. The Focomat Enlarger can be adapted for use with any 50mm Leica lens.
3. There are three different settings on the focusing ring of this enlarger. These settings are used with the different film holders, such as, the regular holder for receiving rolls of Leica film, and also the glass plate holder which holds the film in a slightly different plane for enlarging.
4. A magnification scale is included.
5. On the upright pillar there are two holes. The upper one is for use with the enlarger when the paper holding easel is in position. The lower hole is used for marking the position of the bracket on the lamp housing when the easel is not to be used.

The Focomat Enlarger is focused with one of the Leica lenses at the Leitz Company in New York before delivery. Once this setting has been made, there is no need for making a change. Any of the 50mm Leica lenses may be used or the special Varob Enlarging Lens can be used. The

Varob lens is really recommended because this lens can be left on the enlarger continually and it will not be necessary to use the lens from the Leica Camera.

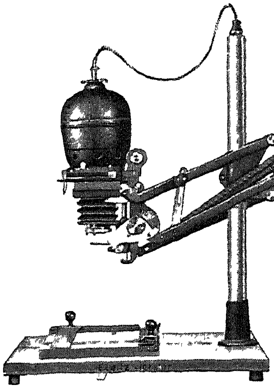


Fig. 101 Focomat Enlarger which accommodates all negative sizes up to 2½ x 3½ inches.

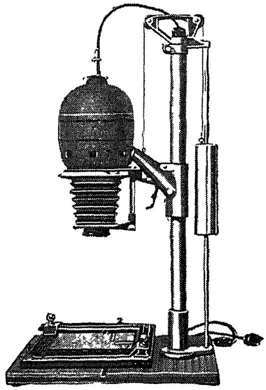


Fig. 102 Vanos Enlarger for use with all negatives up to 2½ x 3½ inches. Note counterweight for balancing weight of enlarger.

Enlarger Accessories

There are various accessories for use with the Valoy and Focomat Enlargers. Masking plates for use with single frame, double frame, 3 x 4cm, and 4 x 4cm negatives may be used in these enlargers. Glass plate negative holders are also available for enlarging single negatives. The 2½ x 3½ Focomat and Vanos Enlargers accommodate all film sizes up to their maximum areas. Orange filters are also of value when making enlargements or glass lantern slides. A special attachment ring is available for fitting to the Elmar or Hektor 50mm lenses. This ring permits the operation of the iris diaphragm by turning a knurled ring with a special calibrated scale on the side. In this way it is very easy to read the lens stops from the side of the ring. As all enlargements should be made with the lens closed down at least two or three stops, such a ring is recommended. Preliminary focusing is done with the lens wide open.

The Vanos Enlarger

The Vanos Enlarger is designed for enlargement of all sizes of miniature camera negatives. This enlarger will accommodate all films from the single frame size of 35mm film to 2½ x 3½ inches. Its optical system is so arranged that the Leica interchangeable lenses can be used in it. As standard equipment a 95mm lens is available. The focusing bellows is adjustable for use with other interchangeable Leica lenses. The Vanos Enlarger as well as the large size Focomat Enlarger have stationary condensers. A special optically flat glass sandwich plate is used for holding Leica films or cut films up to 2½ x 3½ inches, otherwise the method of using the Vanos Enlarger is practically identical with that of the Valoy or the small Focomat Enlarger.

A special Offset Arm is also available for use with the Valoy and Focomat Enlargers. This Offset Arm is of special value when making big enlargements because the lamp housing is extended an additional 6 inches away from the upright pillar. As the Offset Arm contains a short rod itself, it is possible to raise the lamp housing of the enlarger about 18 inches higher than the top of the regular upright bar which comes with the enlarger. Even when making huge enlargements up to 2 or 3 feet or greater, this Offset Arm can be used very successfully in the horizontal position. The arm may be moved vertically or horizontally by loosening the set screw and turning the attachment in various positions. In the horizontal position as shown in the illustration, the picture may be projected upon a wall for making the huge enlargements.

If the Leica lens is used without the Adjustable Diaphragm Ring, the figures engraved on the lens mount represent the following ratios:

Relative Aperture:	1.9 (2.0)	2.5	3.2 (3.5)	4.5	6.3	9	12.5	18
Ratio of Exposure:	0.36	0.63	1	2	4	8	16	32

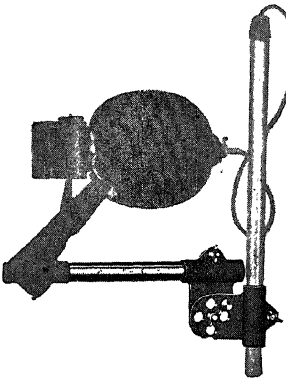


Fig. 103 Offset arm for making great enlargements

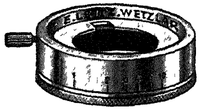
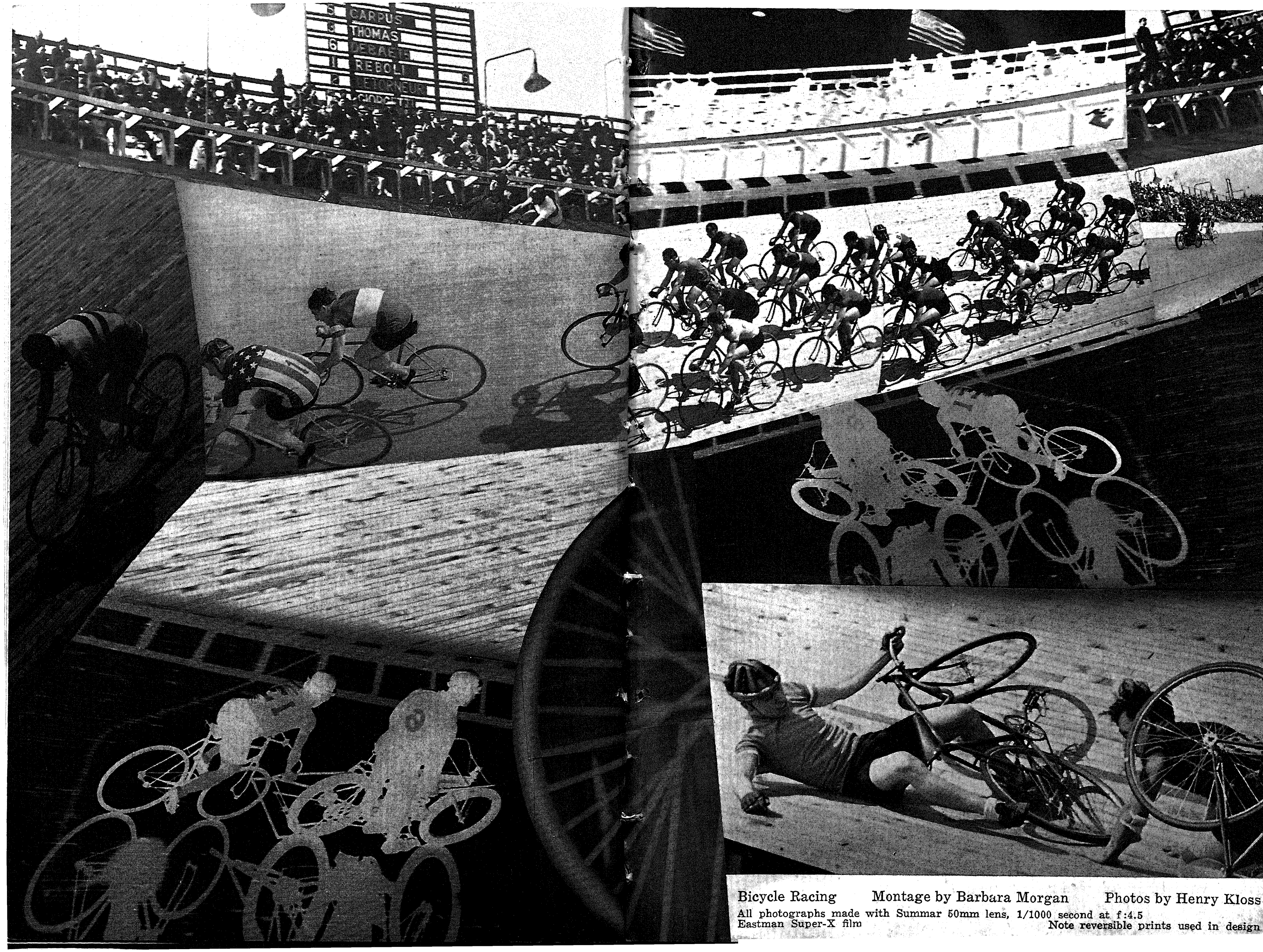


Fig. 105 Diaphragm Ring, available for Elmar 35mm and 50mm, and for Hektor 50mm lenses when these lenses are used on enlargers

Making the Actual Enlargements

Now let's suppose that the Valoy Enlarger has been selected and we are ready to make our first enlargements. First, check up on the darkroom equipment and make certain that the following materials are available:

1. The Valoy Enlarger.
2. Developer, short stop, and hypo solutions as well as trays. The trays can be selected for the size of enlargements which will be made. A set of 5 x 7 and 8 x 10 inch trays are always of value.
3. Enlarging paper. (See next chapter on Enlarging Papers).
4. Check up on the proper safe-light and other accessories for the darkroom use. (See chapter on the Leica Darkroom).



Bicycle Racing   Montage by Barbara Morgan   Photos by Henry Kloss

All photographs made with Summar 50mm lens, 1/1000 second at f:4.5
Eastman Super-X film   Note reversible prints used in design

After all, there is very little equipment required for making Leica enlargements. You can easily confiscate the kitchen sink and drain board for this work after the windows have been covered with a blanket or black cloth. The darkroom chapter will give you more complete information about becoming *a bathtub finisher.*

Before placing the Leica negative into position in the Valoy Enlarger, make certain that there are no dust particles clinging to the film. If there are, remove them with a soft brush or with a clean lintless linen cloth. The movable condenser should always be inspected for dust or dirt particles. These points are very essential because small dust particles may spoil an otherwise perfect enlargement if they are not removed beforehand. The Negative Viewer and Marker can be used very successfully for picking out the best negatives for enlarging. With this attachment, it is possible to make a small nick in the edge of the film. Then, while working in the darkroom, the negatives can be picked out very quickly by running a thumb along the edge of the film.

When the correct negative has been selected, insert the film into the negative carrier of the enlarger **with the emulsion side down**. Snap on the light and move the film so that it appears in the frame which is projected down onto the paper holder. This can be done while the condenser is in the raised position. Next, move the clamping lever forward in order to release the condenser and thus clamp the film into a plane position. Now, raise or lower the lamp housing and turn the focusing mount, into which the Leica lens has been screwed, until sharp focus has been secured over the entire picture area.

Some Leica workers secure critical focusing by placing special negatives with sharp line drawings in the enlarger before the regular negative to be enlarged is inserted. Then, when perfect focus is secured by projecting the lined negative onto the enlarger easel, the focusing negative is removed and replaced by the regular film strip. A black over-exposed frame can also be used for this purpose providing a few fine scratches are made on the emulsion side of the film.

A hand magnifier or reading glass can also be used for viewing the projected image on the enlarging easel. Sometimes this latter method is very convenient for securing critical focus.

The enlarging easel should be set for the proper size of the enlarging paper. The two adjustable masking bands can be moved for making the proper adjustments. It is best to have a small white margin around the finished enlargement. This white margin can be varied according to requirements.

After the projected negative is properly focused and centered on the enlarging easel, you are now ready to make an exposure test. Select a small strip of enlarging paper and place it on the easel with the emulsion side up. Stop the lens down to one or two diaphragm stops. A small pencil flash light may be used to make the adjustment of the lens diaphragm. This flash light can be covered with a piece of red paper. With the proper lens stop set you are now ready to snap on the switch and expose the test strip. Two or three different exposure times should be made on this test. A small card can be moved across the test strip at one or two second intervals, depending upon the speed of the paper and also the density of the negative. With a little practise it is very easy to count seconds without watching a clock. There are various methods used for counting. For example, seconds can be counted in this way: Thousand 1— Thousand 2— Thousand 3—. Or, if this may be too monotonous, try the following: 1 chimpanzee, 2 chimpanzee, 3 chimpanzee, etc. There are excellent darkroom clocks with second hand dials for use in timing negatives on enlarging papers.

The diaphragm stops on the enlarging lens can be more easily seen if a small white card is placed just below the lens in order to throw the reflection of the light back onto the lens. The card can be bent in such a way that the light will even be thrown around to one side of the special attachment ring in case it is used for adjusting the diaphragm stops.

After the test strip has been exposed, place it in a developer and develop for a full time of 1½ to 2 minutes in case of bromide papers. If the slow chloride contact paper is used, the developing time will probably be about one-half the time required for bromide paper. After the test strip has been fully developed, rinse it in the fixing bath for a few seconds and then turn on the white light and examine the exposures. The correct exposure can usually be determined very quickly. Now place a full size sheet of enlarging paper in the enlarging easel and snap on the light for the required length of time. Remove the paper and place it in the developing tray. After proper development, rinse the picture in the acetic acid short stop which is made up as follows:

Acetic Acid (28%)	**1½ oz.**	**48 cc**
Water	**32 oz.**	**1000 cc**

From the short stop the print is placed in the acid fixing solution for about 15 minutes. See the next chapter on Printing Papers for information about the acid fixing solution.

After the picture has been thoroughly fixed, it should be washed in a tray in running water for at least one hour before placing out to dry on blotters or in the special blotter roll which is now available.

Estimating Print Density

Some people have a very easy time turning out excellent prints which embody everything that is known as *quality*. Others have a hard time making good prints. It is true that some people have a gift for such work, having the ability to put *quality* into their prints by instinct or intuition, but even the average person who lacks that *spark* should be able to turn out most satisfactory prints after once getting the *feel* of making them.

Let's see what is involved in the process of producing a latent image upon a sensitized paper and subsequently converting that latent image into a real image in terms of black and white and the intermediate tones of these two colors.

The emulsion of the paper coats the surface very similarly to that of a coat of paint. Paint consists of a vehicle, which is usually linseed oil or other more or less volatile substance, and tiny particles of pigments suspended in the vehicle. The emulsion of the sensitized paper consists of gelatine, the vehicle in which particles or grains of light-sensitive silver bromide, chloride or a mixture of both are suspended. The emulsion has a thickness. This thickness may vary with the different types of papers. There are particles of sensitive silver salts that are near the upper surface of the emulsion and some that are joined to the surface of the paper. And there are particles of these salts scattered in between. When light strikes the surface of the paper, after passing through the negative, it strikes the sensitive silver salt grains. If little light reached the surface of the emulsion, only those silver grains become affected by it that are nearest the surface. The more light that reaches a certain point of the paper, the deeper it penetrates into the emulsion and the more particles of silver salts are affected by it. Obviously a certain minimum amount of light must be admitted to the surface of the paper to affect the lower layers of silver salts imbedded in the emulsion.

After exposure, the latent image produced upon the emulsion of the paper must be developed through conversion of the silver salts into metallic silver grains. When the print is immersed in the developer its chemicals begin to react with the silver salts in the emulsion after the water of the developer softens the dry gelatine. The particles of developer gradually penetrate into the thickness of the emulsion until they reach all the way through it to the paper proper. Obviously a certain minimum of time must elapse between the time when the uppermost grains of silver are developed and the time when the lowermost grains are converted into silver.

This is the reason for the requirement of paper to be developed for a minimum time before withdrawing it from the developing solution. In most instances that minimum time for bromide and chlorobromide is set at one and one-half minutes. That is the **minimum** time of development. If after the printing has been developed for one and a half minutes, and not less, it appears weak and flat, it apparently has been underexposed and more exposure should be given. If it appears to be too dense it has been apparently overexposed and the subsequent exposure should be shortened.

Longer development than the minimum of one and a half minutes is frequently indicated. Some prints acquire a certain tone quality through longer development. Thus it can be said that with certain developers for instance after a minute and a half development almost all details of the picture are available and the development is continued for another half minute with very little apparent change taking place in the print. But when finished and dry such print will have that *quality* and *richness* which we always look for.

An excellent and frequently overlooked method of learning how to make good prints consists of making some prints on lantern slides or on positive cut film. The emulsion of lantern slides and positive cut film is similar to that of bromide papers. Lantern slides and transparencies made on positive cut film have a greater brilliance and greater latitude than bromide papers. This is only measurably true. Their emulsions being almost the same, the difference of quality results from the viewing method employed, slides being viewed by transmitted light while bromide prints are viewed by reflected light. This difference will become quite apparent when one will visualize a cross-section of an emulsion similarly exposed. Bromide paper emulsion and lantern slide or transparency emulsions of a similar negative would show under great magnification that the densities

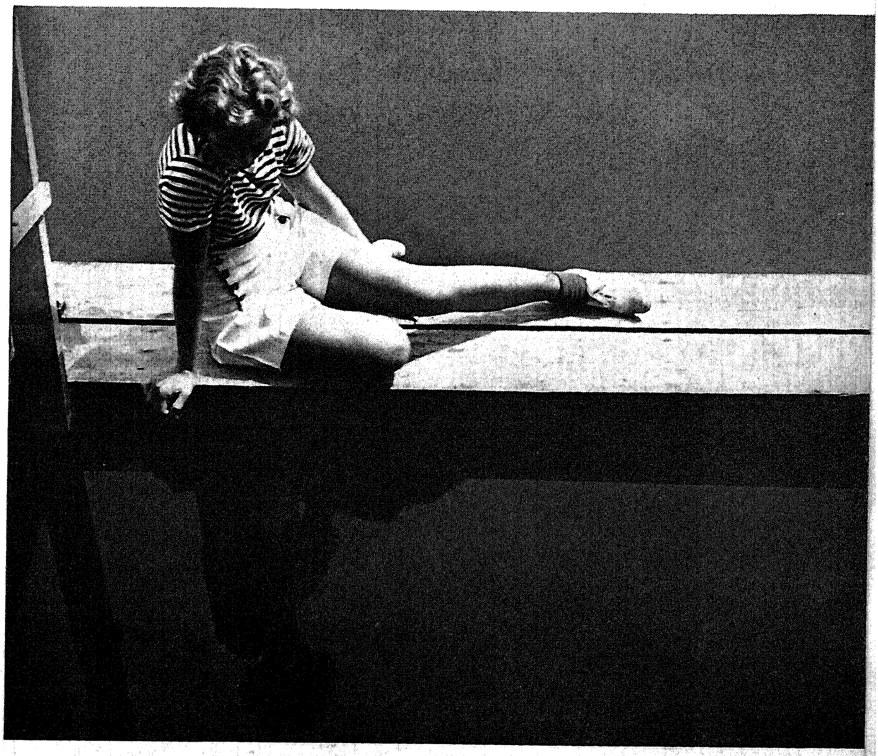


Fig. 107 Reflections G. J. Daniell

of the deposit of black silver grains are almost identical and they form terrace-like recesses or slopes ranging from blackness merely at the surface of the emulsion to total blackness of the entire thickness of the emulsion. It is easy to see that transmitted light penetrates through these layers of different degrees of blackness with a different intensity, thus forming degrees of intensity that can be likened to shades of gray. Light, however, that is reflected from a black surface backed with white paper can produce only a very limited range of tones of gray which would depend on the thickness of the black.

Thus if one would use positive cut film or lantern slide stock instead of bromide or chlorobromide papers for enlargements or portions of enlargements one will begin to evaluate these differences of the thickness of silver deposits. Lantern slides or transparencies must be viewed by transmitted light. Viewing them in a developing tray will produce unfavorable, erroneous results. A transparency that may look fully developed in the tray will look flat when viewed against a light box. And one that looks totally black in a developing tray will show excellent brilliance and contrast when viewed against an adequate light source. A dozen lantern slides or pieces of positive cut film would be an excellent investment and one will get more information from such experiments than from a whole volume written on the subject. That is the only way to get the *feel* of the matter and it cannot be recommended strongly enough. Later on, after having made a number of prints in the form of transparencies one may adopt the same method for judging prints: when they are developed according to a standardized method and fixed, view them against some strong source of white light, while wet, and if your print looks good that way, it certainly will be good when dry and finished.

Prints should be wet when viewed through transmitted light, particularly those made on double-weight paper which may require a stronger source of light than those made on single-weight paper.

Incidentally it should be remembered that lantern slides and cut film transparencies can be developed in the same developers which are used for developing of bromide or chlorobromide papers.

Printing Control During Enlarging

The enlarging of a negative permits much greater latitude in the actual printing control as compared to contact printing. During enlargement, it is possible to introduce soft focus lenses, special diffusion screens, and also use special paper masks or other means of *dodging* the picture during exposure. While contact printing permits very little variation in the finished print, a little shading is about all that can be done above the negative during exposure.

Dodging may be necessary when printing a negative in which the sky is considerably overexposed while the foreground may be normal or even underexposed. The correct exposure is made for the foreground and then a cardboard is used to mask out the foreground while the sky is given a few additional seconds in order to bring out the clouds or to keep the sky from printing white. With a little practice

Fig. 108 Tea Time Morgan Heiskell

and ingenuity the operator can devise various methods of *dodging or shading.* For example, a large cardboard can be cut with a round hole through which the picture may be projected as required for bringing out certain effects in the print. Also, small cardboard discs can be attached to a thin wire when it is necessary to hold back certain portions of the picture during exposure. In case there is considerable dodging to be done on a print, the diaphragm on the enlarging lens can be stopped down several stops more in order to give a longer working time. During the shading process, it is quite essential to keep the cardboard moving in order to prevent a sharp line from appearing where different exposures are made. A little practise will eliminate this trouble. Many enlargements can be shaded simply by moving the hand below the enlarging lens and thus blocking out any part of the picture which may be necessary.

Still other methods of control are possible by using a supplementary soft focus lens in front of the enlarging lens or a thin piece of tulle may be mounted in a holder and moved around just under the lens during the exposure. Also, special effects may be secured by placing screens directly over the enlarging paper. Sometimes these

screens are printed on glass plates in order to give a small space between the screen and the paper and thus permit a slightly softer result. Still another method of obtaining special effects on the enlargement is by using a clear glass plate with fine sand sprinkled around the plate where the background of the picture is to be held back or diffused. For example, the backgrounds of portraits may be printed by this method.

Although many people like to use these special methods of securing certain results, the ideal way is to make the enlargement naturally without diffusion or the use of special screens which only give a false effect in an attempt to imitate etchings and lithographs. It is not necessary to make the original Leica negative through a diffusion lens. Once a sharp negative is available, it can be used for any purpose thereafter.

Some enlargements may be greatly improved by skilfully using an ordinary flash light for overexposing certain areas, while the rest of the paper is covered. In doing this, the orange filter is moved over the lens of the enlarger in order to prevent exposure on the paper. However, the projected red image will guide you in flashing the light over the areas which are to be darkened. Thus a sky may be made almost black for special effects, or, the background of a portrait may be darkened or graded off. Still another method of using a flash light is for making a small narrow black margin around the printed picture while it is still in position in the enlarging easel. To do this, cut a sheet of cardboard slightly smaller than the final picture will be. This cardboard is placed over the sensitized paper in the enlarging easel. By moving the card into one corner there will be two sides left with a margin of possibly ⅛ or ¼ of an inch. Slowly pass the flash light along this exposed margin. Then, push the card into the opposite corner and continue around the other two sides. When the paper is developed, the image as well as the black margin will appear on this same print.

The Use of Photoflood Bulbs in the Enlarger

With the introduction of the photoflood bulbs, it is now possible to use greater illumination in the Leica enlargers. With a photoflood bulb, the slow chloride contact papers can be used very successfully. As these papers require considerably longer exposure as compared to bromide papers, the photoflood illumination is perfect for making the exposures. Very dense negatives can likewise be used with the higher illumination available from photoflood bulbs.

A rheostat or illumination control is recommended for use with the photoflood bulbs. Such controls are available at your photographic dealer. The Leitz Illumination Control is made for one photoflood bulb and contains seven different stops for varying the intensity of the illumination. Also, there is another illumination control known as the Variac manufactured by the General Radio Company in Cambridge, Mass. The Variac Transformer can be used for delivering voltages between zero and 130 volts from the 115 volt circuit. The Variac does not overheat if operated continuously

and this transformer will control any number of photoflood lamps up to four. Such a method of controlling the photoflood bulb in the enlarger is ideal because it is not always necessary to have the bulb burning at its brightest intensity for making enlargements. By turning down the voltage and using the bulb at less illumination, it is very easy to do all the focusing of the negative and thus prolong the life of the photoflood bulb as well. The Variac Transformer is designed for use on alternating current lines only.

It should be noted that only photoflood bulbs especially designed for enlarging purposes should be used. Ordinary photofloods have the manufacturer's emblem at the tip of the bulb which will cast an objectionable shadow upon the image. This emblem cannot be removed by ordinary methods. Special enlarger photofloods are made with the manufacturer's emblem placed along the bulb's neck. Subsequently a photo enlarger bulb made by the General Electric Co. frosted inside and out for better diffusion is known as the 200 watt, 105 to 120 volt photo enlarger bulb.

Occasionally a photoflood bulb may break or crack in the enlarger. Therefore, it is a good plan to place a small square of clear glass over the movable condenser in order to prevent it from being scratched by a bulb which may possibly break. Also, a special ventilating ring is available for placing below the upper half of the lamp housing. This ventilating ring will keep the enlarger from overheating when the photoflood bulb is burned for any length of time for making the longer exposures.

Frequently it is possible to make a number of interesting pictures from one negative. In other words, a negative may contain two or three different compositions of special interest. Individual portraits can be selected from a group picture by greater enlargement of the negative. Naturally when negatives are to be enlarged to any considerable size, it is quite essential that they have fine grain development in their original processing.

Reduction of Leica Negatives by Projection

In the chapter on Making Leica Film and Glass Positives, there is special information about reducing Leica negatives, or, printing Leica negatives in natural size. Considerable interest may be created by preparing a series of Leica enlargements as well as a number of Leica reductions from the normal size of Leica negative. When making the small prints, a 3, 6 or even 9cm Extension Tube may be placed between the enlarger and the enlarging lens. In this way it is even possible to reduce a Leica picture to ¼ of an inch in diameter if necessary. Such small miniature pictures may be used for ring or locket settings as a novelty.

Micro slides can be successfully enlarged by direct projection in one of the Leica Enlargers. Many medical and professional workers will find this method of enlarging micro sections of special value for study and filing purposes.

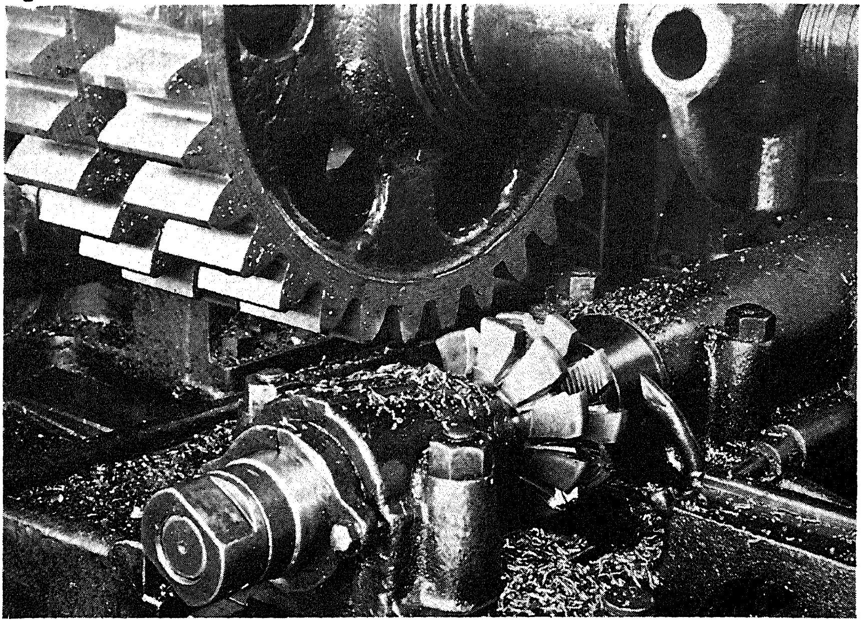


Fig. 110 Gear Cutting I. Luckman
Summar 50mm lens, 5 seconds at f:12.5
Perutz Persenso film

Contact Printing

It is also possible to make your "contact" prints by projection. Once the correct setting has been determined, the entire strip of film can easily be printed within a few minutes after a few test strips have been made. With a little skill it is also possible to print all these test strips onto one large sheet of paper and then the entire sheet placed in the developer. This method is recommended for filing purposes especially. The individual prints can be numbered and the number of the roll as well as any other data may be placed at the top of the sheet of paper. If desired, a master negative 8½ x 11 inches in size could be made for printing the numbers as well as the outlines of the picture spaces before the contact prints are made on the sensitized paper. For this purpose, a special enlarging easel can be constructed with notches or guide lines and the easel is thus moved from frame to frame as the prints are made.

Actual contact printing is done by placing the Leica negative in direct contact with the sensitized photographic paper. The emulsion, or dull side of the negative, must face the emulsion side of the paper. In other words, contact printing is really natural size printing where the printed picture is

exactly the same size as the original negative. While working in the darkroom one may be doubtful about the emulsion side of the paper. A quick test can be made by touching the tongue at one corner of the paper. The side which feels slightly sticky is the emulsion side which is also slightly shiny.

The most elementary way to make a contact print is to place a strip of photographic paper, emulsion side up, on a smooth surface. Then, place the negative face down on the paper and force complete contact by pressing a glass over both. This setting is naturally done under the usual darkroom safelight for paper. The white light is turned on for making the exposure on the contact print. The enlarger can also be used as a light source for this purpose very readily. In case the enlarger light is too strong, one or two sheets of tissue paper placed in the film plane of the enlarger may be used to soften the illumination. After exposure the paper is developed.

However, most workers prefer a neat printer for making their contact prints. Such a printer can either be made or purchased. The Eldia, Eldur, and Laver Printers supplied by the Leitz Company can all be used for making paper contact prints as well as for contact printing on film or glass slides. The Willo strip printing frame made by Willoughby's or the Agfa printer can also be used for printing single frame and double frame negatives.

The chapter on Printing Leica Positives gives detailed information about using the Eldia, Eldur and Laver Printers. These printers are also illustrated in that chapter. In the Eldia Printer, the paper can be wound around the spool with the negative. Then, the empty spool on the opposite side of the printer is turned so that the paper and film both advance at the same time. The exposures are made by turning on the enlarger light or any other strong source of illumination may be used. This same method of printing can likewise be used in the Laver Printer. The Eldur Printer and also the Glass Slide Printing Attachment for the Laver Printer can be fitted with a small metal pressure plate for use when making individual contact prints on 2 x 2 inch paper which has been previously cut for the purpose.

A number of Leica users have even made a contact printer by taking two pieces of plate glass cut 5 foot strips and 35mm in width, or the exact size of the film. One side is hinged with tape. With this printer it is very easy to place a negative film in position and a strip of unexposed contact paper over the film. The two glass plates hold both in perfect contact during the exposure when the white light is turned on. Such a method is very rapid although it is necessary to make a normal estimate of the exposure for the entire strip or film.

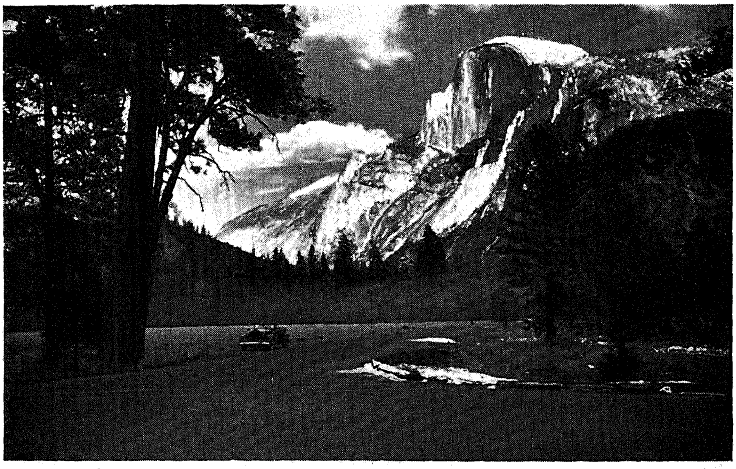
Single contact prints or paper strips containing 4 or 5 exposures can easily be developed in trays. However, when longer strips of 3 or 5 feet are to be developed, it is necessary to use a special developing tray with a roller weight at the bottom under which the paper strip is passed. During development, the paper strip is quickly passed back and forth through the developer in the tray. Such developing trays may be secured from your photographic dealer. These trays can also be used for developing film strips if special care is taken. When using the Azo 35mm perforated or unperforated paper which may be secured in 200 foot rolls, the developing time will be approximately 45 seconds, when using the D-72 Eastman Formula at a dilution of one part of developer to two parts of water. A different developer and time must naturally be given when developing negative or positive films in this type of tray.

Still another method of developing strip paper is by using the Correx

or Reelo Developing Tanks. The paper is wound into the reels similar to the method used for inserting and developing film negative strips. When development is complete, the reel can be quickly immersed in a short stop solution for a few seconds and then placed in the fixing bath. If additional paper strips are to be made, the paper must be unwound from the reel, the reel and apron are then thoroughly washed in running water before using again for development. The exposed strip of paper should be left in the fixing solution for at least 10 minutes.

The Agfa Ansco Company supplies the fast Brovira paper in perforated 35mm width for contact printing. The Azo paper supplied by the Eastman Kodak Company as well as the Brovira paper may be secured in the various degrees of contrast.

After the contact print has been made, the single prints can be mounted for quick reference for indexing purposes on individual cards or in a special photo album. Special mounting masks are available for preparing the individual contact prints for filing. There is also the Willoscope available for viewing single contact prints. This little device has a magnifier and also a place to hold the single contact print for viewing. This viewer also contains a space for the contact prints and at the same time it can be folded in a very small space and carried in the pocket. The method of printing or mounting the individual pictures on a sheet 8½ x 11 inches in size may be of great value for filing purposes. In fact, contact prints could be used more generally than they are, not only for filing purposes and keeping track of negatives, but also for making attractive contact print albums. Contact prints assembled according to subjects and special layouts with a few captions would certainly make an attractive album. It is surprising how much may be seen even in a small contact print.



Mountain Scene — Ernst Schwarz

Elmar 35mm 1/30 f:5 Agfa Superpan, medium yellow filter.

ENLARGING PAPERS AND PRINTING

ƐERT M. LUDLAM

CHAPTER 8

The average user of a miniature camera is having relatively little 'culty in turning out negatives of reasonable quality. Exposure ers representing but a fraction of the first cost of the camera have ıinated the guess-work in negative making, particularly since ɩiature negatives are developed uniformly for a given time at a d temperature. Nevertheless, the prints of most workers do not n to satisfy them, and one is continually asked, "Why don't my ıts have *life?*"

The answer is fundamental to miniature photography. In order ›btain a minimum grain size, we are using developers of very low ʳer and are developing only to some point of compromise between mal contrast and the smallest grain. Photographers using larger atives develop in solutions of considerable power and carry de- ›pment much further. Consequently, the contrast of their nega- s is considerably greater than that of ours. Years before the ent of miniature photography paper manufacturers recognized need for papers whose inherent contrast corrected for mistakes development and began producing papers in several degrees of trast (soft, medium, hard, etc.). It was found that a negative a certain contrast had become the accepted standard and the ıufacturers designated as normal, or medium, that paper which duced the most pleasing print from a negative of this quality. ɜe the formulas recommended by manufacturers in every pack- of paper are based on this average negative, we must consider negatives in the class which manufacturers call *weak* or *flat* nega- s and accordingly must use the contrasty formulas or papers ›mmended for such negatives.

Because of the misleading nature of the term *normal* or *medium* ıpplied to papers, most workers in miniature photography believe t they should not have to use any other paper if their negatives e been correctly exposed and developed. Rather should the be- ner, if he must follow a hard and fast rule, consider the use of

papers of greater than normal contrast as being the standard with miniature negatives. In those cases where the paper is furnished in only one grade the contrast formula recommended by the manufacturer should be used. If this rule is followed, nine out of every ten negatives which at present are unsatisfactory will become valuable additions to the tyro's file.

Choice of Paper Stocks and Surfaces

Printing papers today are produced in so many surfaces that it would be impossible to give any comprehensive list. Different manufacturers use widely differing designations for papers of very similar surfaces, so that the only satisfactory way of choosing some special surface is through an inspection of samples. If the prints are to be reproduced they should be made on glossy paper and ferrotyped unless the reproduction is to be considerably smaller than the original, in which case semi-matt papers are quite suitable. One of the most beautiful surfaces is obtained by using a matt or rough matt paper and waxing the finished print with a waxing solution obtainable in any photo supply house.

The paper stocks most commonly used are white, cream and buff; the most common weights being the single weight, generally used for contact work, and the double weight or light card, usually associated with enlargements. Prints which are not to be mounted in albums or on regular mounts are much more satisfactory on double weight stock, while prints for mounting, particularly in albums, are best made on single weight stock. No hard and fast rule, however, can be attempted. With regard to the color of the stock itself, it should be remembered that black and white prints are not satisfactory on buff tinted mounts, nor are buff tinted stocks satisfactory on gray mounts; white, however, is satisfactory with almost any stock.

Tone Gradation

It is impossible to reproduce on paper every gradation of gray available in the negative. This holds true of contact printing as well as enlarging. Sensitized paper has a much shorter scale than negative material. The reason for this is the fact that a picture is seen on paper by reflected light while a negative is examined by transmitted light. The white of the paper will not reflect more than 50 per cent of the light falling on it while the blackest part of the print will still reflect at least 2 per cent of the light leaving a difference in tone of perhaps 25 to 1 as compared with 60 to 1 in the negative, since the densest part of a negative may only transmit one-sixtieth of

first learn to make excellent pictures with the fundamental process of photography.

Generally the tone gradation scale is shortest in fast projection papers and is longest in slow papers. It is claimed that the longest scale range can be obtained in contact or so-called chloride papers. Contact papers are available in as many as six grades of contrast while projection papers only in two or three. Thus the choice of a proper degree of contrast in contact paper will enable one to obtain sometimes a better print on contact paper than on projection paper, provided a suitably strong light is available. Although I have myself recommended the use of contrast grades of paper at the beginning of this chapter and again here, it must be remembered that this is only for beginners. Normal and soft grades of paper produce beautiful middle tones even in the contrast developers recommended by the makers. Contrast, hard, vigorous papers etc. have not as yet been perfected to the point where they can produce the full tone scale of a medium grade paper. The more advanced worker has found other means of building up the contrast, either in development of the negative or in later steps such as the enlarged negative processes. However the beginner will get very acceptable prints by following the simple process of using the contrast grades of paper or the contrast developers.

Fast Projection Papers

Fast projection papers are commonly known as bromide papers because silver bromide is the sensitive agent in their emulsions, in fact, the emulsion is very similar to that of slower plates and films. Most of these papers are made in several degrees of contrast as well as a variety of surfaces and stocks as mentioned above. Some idea of the papers commonly used, which fall in this class, can be obtained from the following list:

Brovira	produced by the	Agfa-Ansco Company
Velour Black	" " "	Defender Company
PMC Bromide	" " "	Eastman Kodak Company
Novabrom	" " "	Gevaert Company
Press Bromide	" " "	Haloid Company
Ilford Bromide	" " "	Ilford Ltd.
Wellington Bromide	" " "	Wellington & Ward Ltd.

Slow Projection Papers

Slow projection papers are known as chloro-bromide papers because their emulsions are made up of both chloride and bromide of silver. Because of the presence of silver bromide these papers are considerably faster than ordinary contact papers whose emulsion is made up entirely of silver chloride; they are therefore suitable for enlarging, the exposure in general being approximately four times that necessary for a regular bromide paper. The long range of tones which can be obtained with these papers is making them very popular for portrait and pictorial work as is also their

moderate speed which makes them available both for direct enlargements and for contact prints from paper negatives. The papers most commonly used, which fall in this class, are as follows:

Indiatone	produced by the	Agfa-Ansco Company
Charcoal Black	" " "	Dassonville Company
Veltura	" " "	Defender Company
Illustrators' Special	" " "	Eastman Kodak Company
Vitava	" " "	" " "
Gevalux	" " "	Gevaert Company
Projecto	" " "	Haloid Company
Clorona	" " "	Ilford Ltd.
Mezzotint	" " "	Wellington & Ward Ltd.

Contact Papers

Contact papers are often called chloride papers because they depend for their sensitivity on chloride of silver alone. Being very slow they were seldom used for enlargements until the development of the photo-flood lamp and its use in miniature enlargers. Proper selection of the contrast of the paper will reward the user with very pleasing results. There are so many contact papers available on the market today that any attempt to list them would be wholly inadequate. However, contact papers manufactured by the firms making the projection papers listed above are as follows:

Convira	produced by the	Agfa-Ansco Company
Apex	" " "	Defender Company
Azo & Velox	" " "	Eastman Kodak Company
Novagas	" " "	Gevaert Company
Industro & Nomis	" " "	Haloid Company
SCP	" " "	Wellington & Ward Ltd.

Wickie and Suzanne — Ed. Schaefer
Summar 50mm, f:6.3 Peromnia Film.

Development

The following tables give the formulas recommended by the paper manufacturers for their papers most commonly used in enlarging. The formulas have been grouped in three classes, soft, medium and hard, but it should be remembered, however, that the hard formulas are the ones which should be used with papers produced in only one degree of contrast as their natural contrast falls in the class of medium papers.

SOFT PAPER DEVELOPERS

	NvBr		*GVA*		*D64*		*Artura*		*NvBrMed*	
	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Gram
Metol	80	5.7	29	2.1	26	1.8	23	1.6	48	3.4
Sod. Sulphite	438	31.0	350	25.0	185	13.0	164	12.0	356	25.0
Hydroquinone	24	1.7	42	3.0	28	2.0	20.5	1.5	40	2.9
Sod. Carbonate	328	23.0	280	20.0	145	10.0	64	4.5	328	23.0
Pot. Bromide	15	1.1	14	1.0	19	1.4	11+	0.8	15	1.1
Water to make	Avd.—32 Ounces				Metric—1000 cc					

Novabrom really suggest using any mixture between their softest and hardest formulas to obtain the particular contrast required.

MEDIUM PAPER DEVELOPERS

	D72		*D73*		*Artura*		*D52*		*Haloid*		*V.B.*	
	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Grams
Metol	9	0.6	13	1.0	12	0.9	11	0.8	12	0.9	16	1.1
Sod. Sulphite	131	9.3	193	14.0	178	13.0	164	12.0	176	12.5	164	12.0
Hydroquinone	35	2.5	32	2.3	41	2.9	45	3.2	48	3.4	48	3.4
Sod. Carbonate	197	14.0	365	27.0	136	10.0	109	7.7	176	12.5	273	19.0
Pot. Bromide	6	0.4	4	0.3	6	0.4	11	0.8	6	0.4	16	1.1
Water to make	Avd.—32 Ounces						Metric—1000 cc					

	Soft *Agfa*		Med. *Agfa*		*NvBr*		*D64*		*Wel.*	
	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Grams
Metol	14	1.0	17	1.2	16	1.1	13	1.0	16	1.1
Sod. Sulphite	219	16.0	274	19.0	274	19.0	185	13.0	560	40.0
Hydroquinone	50	3.6	55	3.9	56	4.0	66	4.7	48	3.4
Sod. Carbonate	278	20.0	383	27.0	328	23.0	145	10.0	560	40.0
Pot. Bromide	5	0.4	6	0.4	15	1.1	19	1.4	5	0.4
Water to make	Avd.—32 Ounces				Metric—1000 cc					

VIGOROUS PAPER DEVELOPERS

	GVA		*DsV*		*D64*		*D11**	
	Grains	Grams	Grains	Grams	Grains	Grams	Grains	Grams
Metol	21	1.5	24	1.7	13	1.0	14	1.0
Sod. Sulphite	350	25.0	328	23.0	277	20.0	1094	80.0
Hydroquinone	80	5.7	83	5.9	117	8.3	130	9.3
Sod. Carbonate	525	37.0	219	15.0	217	15.0	360	25.0
Pot. Bromide	15	1.1	31	2.2	25	1.8	70	5.0
Water to make	Avd.—32 Ounces				Metric—1000 cc			

* D11 is for positive film and is shown to indicate the high sulphite content required for film processing as compared to paper.

NvBr—Novabrom. GVA—Gevalux. V.B.—Velour Black. DsV.—Dassonville.

Several two-solution developers could be recommended for use with papers produced in only one degree of contrast. The purpose of separating the developer into two stock solutions is to permit the contrast of the developer to be altered by altering the proportion of the two stock solutions. It will be noticed in the previous tables that Eastman's D64 formula approximates the average in each contrast group.

To those workers who may object to a formula requiring two or three stock solutions, a universal developer formula is offered with the full confidence that it will prove invaluable as an all-round developer for everything except negative films. This formula is comparatively simple to prepare, keeps almost indefinitely, produces beautiful tones on almost any kind of paper, can be used successfully not only for contact papers and projection papers but also for lantern slides, positive films, transparencies, etc. This formula approximates Eastman's D52, which our table indicates as of medium contrast.

Universal Developer

Water (at 125° F)	16 ounces	500 cc
Metol	75 grains	5 grams
Sod. Sulphite (dry)	2½ ounces	75 grams
Hydroquinone	300 grains	20 grams
* Sod. Carbonate (dry)	3½ ounces	105 grams
Pot. Bromide	75 grains	5 grams
Methyl Alcohol (wood alcohol)	4¾ ounces	150 cc
Cold Water to make	32 ounces	1 liter
* If Monohydrated Sod. Carbonate is used	4 oz., 10 grains	120 grams

Dissolve above chemicals in the order given. It will be found that the Hydroquinone and Carbonate will not dissolve completely until after the wood alcohol is added. It will be found helpful to mix the alcohol with an equal amount of cold water before adding it to the solution. Add alcohol and water mixture slowly while stirring. The solution will gradually clear. Filter it into an amber glass bottle. It is ready to use as soon as cool.

This developer works best at approximately 70° F. It should be diluted as follows:

	Stock Solution	Water
For Bromide papers, lantern slides, positive film, transparencies	1 part	6 parts
For Chloro Bromide papers (slow projection)	1 part	4, 5 or 6 parts
For Contact papers	1 part	3 parts

Many photographers like the rich blacks obtainable with an amidol formula such as the following:

Amidol Developer

Water	32 oz.	1 liter
Sulphite	328 grains	23.4 grams
Amidol	10-30 grains	3.6 grams
Pot. Br.	50 grains	0.7 to 2.1 grams

The chief difficulty with amidol is the staining of fingers and the necessity of preparing fresh developer each time it is used. The developer rapidly oxidizes with use, becoming discolored and unserviceable within an hour or so. The addition of 50 grains (3.5 grams) of Pot. Meta-bisulphite to the Sulphite solution when mixing the developer will considerably lengthen its

useful life, particularly if the sulphite and meta-bisulphite are boiled together for several minutes. In using this developer, papers manufactured in several different contrasts must be used, inasmuch as little change can be effected by altering the developer.

The staining of the fingers will not occur if the precaution of rinsing the fingers every time they have been in solution is observed. This should be done in all developing to avoid carrying back into the developer the oxidized solution left on the fingers.

Altering Developers

The amount of bromide given in the stock solutions is the minimum amount required to keep the highlights clear; it may be increased from this point, increasing the warmth of tone, up to the degree of warmth manifested in an olive brown tone. The maximum is about 40 to 50 grams per 32 ounces of ready to use developer.

Aside from modifying the bromide content of developers, variations can be obtained by adjusting the proportion of metol, hydroquinone and carbonate in any MQ developer. For instance, to gain additional contrast, the Hydroquinone, Potassium Bromide and Carbonate can be increased in equal proportion. The increase in bromide is necessary to prevent too vigorous action and will not appreciably alter the color of the print, the additional carbonate offsetting this tendency as well as increasing the developing action. For softer results the metol can be increased considerably if the hydroquinone is decreased proportionately and, if extreme softness is required, the carbonate can also be decreased. Decreasing the carbonate slows up development and gives olive tones, whereas increasing the carbonate increases the speed of development and gives very black tones.

So much for developers. Each package of paper and every magazine offers some variation of the foregoing with sufficient instructions to cover their preparation and use. Because of the complex nature of the developing process and the uncertainty of results, if different developers are used, it is advisable for the beginner to definitely choose one formula and stick to it until he has learned to produce consistently satisfactory results with it, making only such modifications as seem necessary to obtain greater or less contrast or colder or warmer tones.

Exposure

This brings us to the most difficult problem of all, determining the correct exposure for the print.

It should be borne in mind that the final print density is the result of both exposure and development, thus if a test were made and the test strip developed for say two minutes, the subsequently correctly exposed print should also be developed for two minutes.

However, having determined the exposure by these means, it is still necessary to make one or more tests before the final exposure will be decided upon. Most of us in making test prints attempt to conserve our paper by using a small strip, and find it extremely difficult to decide from an inspection of the strip whether or not the exposure really was correct. It has been my experience that if the test includes the whole picture it could be extremely small (same size as the negative) and still a very good estimate of the necessary variation from the exposure given could be made; far better than from a test strip the same size or larger comprising but a small portion of an 8 x 10 enlargement.

Therefore, I prefer to make my test prints 2x3 inches in size using the entire negative. From this slight enlargement (2x) a quite critical examination can be made in bright light after the print has fixed for a minute or two. Not only can the correct exposure be determined but the picture itself can be studied. By cutting an 8x10 sheet into four strips each two inches wide a total of twelve 2x3 test prints can be made with very little waste of paper.

All tests for an evening's work are made at one time and a record of the correct exposures kept. Sufficient fresh developer must be used so that it will not deteriorate appreciably. The correct exposure for the final print is then determined by multiplying the correct exposure for the test print by the necessary factor to compensate for the increased enlargement, as given in the table below:

Exposure Factors at Various Magnifications

Size of Enlarged Image of Full Negative	MULTIPLYING FACTOR *if original test print was:*		
(Neg. 1x1½ in.)	*1x1½ in.*	*2x3 in.*	*3x4½ in.*
1x1½ inches	1	½	¼
2x3	2	1	½
3x4½	4	2	1
4x6	6	3	1½
5x7½	9	4	2
6x9	12	5	3
7x10½	16	7	4
8x12	20	9	5
9x13½	25	11	6
10x15	30	13	7½
11x16½	36	16	9
12x18	42	19	10
13x19½	49	22	12
14x21	56	25	14
15x22½	64	28	16

Another table which proved very helpful is that of squares of certain basic stop values:

f: Values:	1.9	2.2	3.2	3.5	4.5	5.6	6.3	8	9	12.5	18	25
f: Values Squared:	3.6	4.8	10.2	12.2	20.3	31.4	39.7	64	81	156	324	625

RATIO OF EXPOSURE: FIRST STOP USED TO PROPOSED STOP.

First Stop Used—f:	Proposed Stop—f:											
	1.9	2.2	3.2	3.5	4.5	5.6	6.3	8	9	12.5	18	25
1.9	1	1	3	3	6	8	11	18	22	40	90	170
3.5	1/3	1/2	1	1	2	3	3	5	7	13	30	50
6.3	1/10	1/10	1/4	1/4	1/2	3/4	1	2	2	4	8	16
12.5	1/40	1/30	1/15	1/10	1/8	1/5	1/4	1/2	1/2	1	2	4
18	1/100	1/70	1/30	1/30	1/15	1/10	1/8	1/5	1/4	1/2	1	2
25	1/200	1/100	1/60	1/50	1/30	1/20	1/15	1/10	1/8	1/4	1/2	1

A few examples I believe will suffice to show the use of these tables.

First, supposing we have made a test print using the full negative enlarging it to 3x4½ inches. The correct exposure was 10 seconds at f:6.3. Our final enlargement is to be 11x14 losing only a small portion of the negative at each end; i.e., the enlarged image on the easel would measure 11x16½ inches from a 1x1½ inch negative but we will use only an area 11x14 in size.

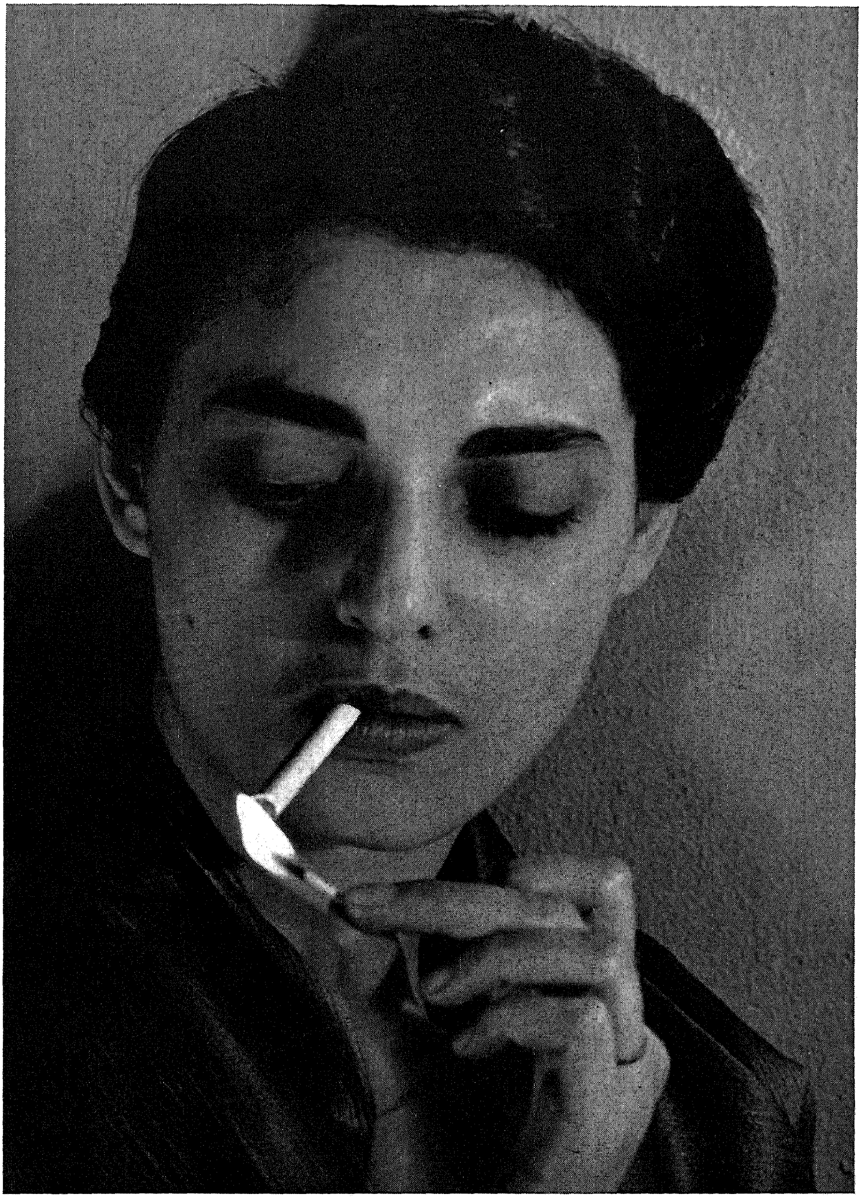
Consulting our first table we find that the exposure should be 9 times that required for one test print or 90 seconds.

Consulting the second table we find that if an exposure at f:4.5 is made it need be only ½ that at f:6.3, so we can open our lens to f:4.5 and expose 45 seconds.

Similarly if we have made an exposure of 30 seconds at f:6.3 and we wish to double the exposure without increasing the time, we find from the second table that f:4.5 requires ½ the exposure of f:6.3, so we open to f:4.5 and use the 30 second exposure, getting the same result as 60 seconds at f:6.3 would give.

One other problem frequently occurring is that when we have made an excellent print 8x10 in size we wish to repeat it on 11x14 without wasting paper.

Consulting our first table we find that an 8x12 print requires 20 times the exposure of a 1x1½ and that an 11x16½ requires 36 times the exposure of a 1x1½. The 11x16½ inch print would then require 36/20 or 9/5 the time required for the 8x12. An exposure double the exposure given the 8x12 would be close enough. This ratio will hold true regardless of the amount of the negative used providing the larger print includes the same proportion of the negative as the smaller print did.



Ruth Henry M. Lester
Elmar 90mm lens, ⅛ second at f:6.3. Du Pont Superior Film, 2 Photofloods

Comparative Speed of Various Projection Papers

Another bit of information which each worker must determine for himself, but which is invaluable, is the relative exposure required for each brand of paper as compared with any others he may use. This is particularly desirable if expensive papers are being used, all preliminary work being done on the less expensive paper and the final print being made at considerable saving.

Figures opposite each paper stand for **UNITS of Exposure Time.**

(UNITS: *seconds, minutes or counts.*)

These data are approximate only and should be used with caution as papers vary greatly in their sensitivity to light:

Agfa Brovira	
Soft	1
Medium	1½
Hard	3
Extra Hard	6
Dassonville	1½
Defender Velour	
Black Soft	2
" Medium	3
" " Hard	5
" Hard	6
Veltura	25
Gevaert Novabrom	
Extra Soft	2
Soft	2½
Gevaert Novabrom	
Vigorous	7
Normal	3
Extra Vigorous	8
Gevaert Gevalux	15
Eastman Kodak	
P.M.C. Normal	1
" Medium	2
" Contrast	3
News Bromide Soft	1
" " Medium	1½
" " Contrast	2½
Vitava Projection	10
Illustrators' Special	20
Vitava Opal	20

It should be borne in mind that there is a definite relationship between the exposure time given a print and the time of development required to bring out as many details of the negative as possible. Most of the developers used for papers are so compounded as to produce a fully developed image in one and a half to two minutes. Prints developed for less than that will not show all details, while those developed for longer are apt to appear flat. However, just as in the case of negatives, a certain amount of latitude is available in some papers, permitting longer exposures and shorter development or shorter exposures with longer development. This latitude will enable the worker, with skillful handling, to obtain a variety of results from one paper. If the negative is very dense and contrasty, a softer print with more details will result from longer exposure

and shorter development, while a soft and flat negative will yield a snappier print with underexposure and longer development.

Definite knowledge of how to obtain these results must be left to the worker himself, **who will fully succeed in the proper control of his paper and developer provided he will select one paper, one developer and learn all there is to know about both.**

Short Stop

After the print has been fully developed it should be immersed for a few seconds (from 5 to 10) in a so-called *short-stop* bath. This bath is indicated for two reasons. It instantly stops the developing processes of the print, and it neutralizes the alkalinity of the developer, preventing the carrying over of traces of developer into the acid hypo fixing bath. This neutralizing action of the short-stop bath is important because it imparts longer life to the acid hypo fixing bath and a more uniform action of same. If this acid rinse bath is used, the fixing bath will fix out almost twice as many prints as it would if no short-stop bath were used. One quart (one liter) of the short-stop bath will process about twenty 8 x 10 prints or their equivalent of smaller prints. Properly prepared, an acid fixing bath (one quart) will fix out approximately thirty 8 x 10 prints or their equivalent in other sizes if the short-stop bath is used between development and fixation or about one-half that number of prints if only an ordinary water rinse is used.

A short-stop bath is prepared by diluting one and a half ounces of acetic acid (28%) with 32 ounces of water (or 48cc to one liter of water). If 28% of acetic acid is not available same may be prepared from glacial acetic acid (a much more economical way) by diluting three parts of glacial acetic acid with eight parts of water. It should be remembered that only a short rinse in this short-stop bath is required (from five to ten seconds) while longer immersion (one minute or more) will degrade the tones of most enlarging paper, will cause blisters and general disintegration of the emulsion of the print.

Fixing

Fixation is of utmost importance, as upon its thoroughness depends in a large measure the permanence of the photographic print. Preparation of an acid fixing bath should be done as carefully as that of development. Fixation is generally complete within ten to fifteen minutes, provided every surface of the print has full access to the bath and that the prints do not stick together. The prints are best kept moving in the fixing bath.

There are three ways of preparing an acid fixing bath: First, for the workers who do not turn out great quantities of prints a very satisfactory way of preparing hypo is by purchasing ready put up packages of powders, which contain all necessary ingredients, and follow instructions on each box.

Second, for those who do more work and like to prepare their own, the following formula is most satisfactory and generally used:

Water	**64 ounces**	**2 liters**
Hypo	**16 "**	**480 grams**

When thoroughly dissolved, add the entire quantity of the following:

Hardening Solution Separately Prepared

Water (at about 125° F.)	5 ounces	160 cc
Sodium Sulphite (dry)	1 ounce	30 grams
Acetic Acid (28%)	3 ounces	96 cc
Potassium Alum	1 ounce	30 grams

Dissolve the sulphite completely before adding the acetic acid. After the sulphite-acid solution has been mixed thoroughly, add the potassium alum with constant stirring. When the alum is dissolved entirely, hardening solution should be cooled after mixing and slowly added to the cool hypo solution while stirring the latter rapidly.

The third method, for those who require large quantities of hypo to be kept for considerable time, is to prepare an acid fixing bath by dissolving two pounds of hypo in a gallon of water and keeping it in a well stoppered bottle. Separately a stock hardener solution is prepared as follows:

Water (at about 125° F.)	**56 ounces**	**1700 cc**
Sodium Sulphite (dry)	**8 "**	**240 grams**
Acetic Acid (28%)	**24 "**	**750 cc**
Potassium Alum	**8 "**	**240 grams**
Cold water to make	**1 gallon**	**4 liters**

Dissolve the chemicals in the order given, following instructions given for formula above.

The fixing bath is quickly made by adding one part of this stock hardener to four parts of cool hypo solution.

Finally, a very effective and economical method of securing hypo for prints is to provide a large bottle and to pour into it all the hypo that has been used once and not more than twice for fixing of negatives. Such hypo is good enough for prints and makes it more practical to use fresh hypo for every film treated.

It would seem unnecessary to warn against the use of old worn out baths, but somehow everybody seems to do it. Hypo, Acetic Acid, Alum and Sodium Sulphite are cheap (even the water hasn't been so highly taxed as some things as yet). Your time and effort in getting a print as you want it are valued at your own price; a worn out bath can stain every print and you won't know it until you turn the bright lights on. Don't take the chance! Another suggestion, thirty seconds devoted to moving each print about in the hypo when first brought over will insure even fixing and prevent unaccountable rings, and other marks from appearing during any later treatment. One more, when a bath becomes milky, either through use or old age, throw it away.

Washing

Having brought a print to this point with success, one looks forward to the prideful joy he will experience when showing it to friends and then tosses it into a tray of water into which a dozen other prints will be similarly tossed before the first is removed, supposedly completely washed. With the water running full force a print cannot be thoroughly free of hypo if other prints have been continually brought over from the hypo bath. **Washing should continue for at least a full hour after the last print has been brought over, preferably rinsing each print as it is taken from the hypo.** Washing

cannot be stressed enough if permanency is desired, as any trace of chemical left in the paper will discolor or fade the print, perhaps not in the first six months, but a well washed print will last for years.

Thoroughness of washing after fixing is just as important as every other step in preparing a good print. A print insufficiently washed will deteriorate just as a print insufficiently fixed. The water used for washing prints should not be colder than 65° nor warmer than 75 to 80°. Washing should be complete in an hour's time if the prints are moved about and the water constantly changed. The Eastman Kodak Company makes and sells an excellent tray syphon which if used in accordance with instructions accompanying it, makes a most ideal aid for thorough washing of prints. This device is easily attached and is absolutely fool-proof and safe in its operation.

Hypo Test

It is highly advisable to apply a very simple hypo test to be sure that the prints are completed *washed.*

The following **Hypo Test Solution** is recommended by the Eastman Kodak Company and is known as **Formula HT-la:**

	Avoirdupois	Metric
Potassium Permanganate	4 grains	0.3 gram
Sodium Hydroxide (Caustic Soda)...	8 grains	0.6 gram
Water (distilled) to make..........	8 ounces	250.0 cc.

To make the test, take 4 ounces (125cc.) of distilled water in a clear glass and add ¼ dram (1cc.) of the permanganate-caustic soda solution. Pour ½ ounce (15cc.) of this diluted solution into a clean 1-ounce graduate. Then take six 4″ x 5″ prints or their equivalent from the wash water and allow the water from them to drip for 30 seconds into the ½ ounce of test solution. If a small percentage of hypo is present the violet color will turn orange in about 30 seconds and become colorless in about one minute. In such case the prints should be further washed until no color change is produced by the test which proves that the hypo has been eliminated.

Drying

Drying the print offers very little difficulty if a few points are remembered. Curling is due to uneven drying more than anything else. If the surface water is not wiped off, it will collect in pools leaving, at times, dents in the print which, when finally dried out, shows strain marks in the gelatin. A print carefully wiped dry with a viscose sponge and then dried on cheese cloth, face down, will have so little curl as to flatten of its own accord when filed away. Even when dried face up on a blotter, the curl is not objectionable. The Eastman Kodak Company produce a print drying roll con-

sisting of a long length of corrugated paper together with two similar lengths of blotting paper, the one faced with a specially prepared cloth to prevent sticking to the face of the print. The two lengths of blotting paper and the corrugated paper are rolled over a cardboard tube, forming a roll approximately 10″ in diameter. Prints to be dried are laid between the blotters facing the cloth. The roll may be placed before a fan or left standing. When the prints are dry they will be found to have a backward curl, quickly becoming flat when removed.

Ferrotyping

There are two types of tins available for ferrotyping prints requiring high gloss finish. The least expensive are black enamel tins. Slightly more expensive but very practical are chromium plated tins. Either type will produce excellent results indefinitely if they are well cared for. They scratch easily and should be protected from rough handling, grit and dirt. They should be carefully washed with a wet chamois or viscose sponge directly after use. When stored they should be interlined with line paper or wax paper, placed face to face. Do not allow your chemicals or solutions to remain on your ferrotyping tins for any length of time as they will eat into the enamel eventually causing blisters and corrosion, thus rendering the tins useless.

Ferrotyping to produce really glossy prints is not a difficult matter if a few precautions are followed. Glass, coated with paraffin or beeswax has been suggested from time to time but is never really successful. Ferrotype tins are too cheap to consider such substitutes. The tin must be thoroughly cleaned with a soft cloth and a few drops of benzene or hot water every time any particle is noticed to be adhering from the last prints. The tin should then be lubricated with a solution of paraffin in benzene (10 grains of paraffin to 1 oz. of benzene, 1 gram to 50cc). A few drops of this solution rubbed evenly over the tin and then polished gently with a soft cloth is sufficient; this need not be repeated unless it becomes necessary to clean the tin with hot water or benzene to remove particles stuck to the tin. Normally it suffices to polish the tin with a soft cloth each time it is used. Only glossy paper, specially coated for ferrotyping during manufacture, should be used. The print should be brought from the wash water, rinsed under the tap, and without draining laid face down on the tin and squeezed dry. Too much pressure may cause the prints to stick; not enough, and they will not get good contact with the tin and will have an uneven gloss. Little difficulty, however, will be experienced as the latitude is considerable. The tins are then set aside to dry in any warm spot with a current of air, such as a window. Drying should take several hours at least; artificial heating is not good, causing sticking and uneven drying which leaves strain marks. If, on the other hand the prints are left in a damp place, or sufficient air is not allowed around them, such as setting one tin next to another separated by only a fraction of an inch, the drying will proceed from the edges in and a ring shaped strain mark will develop. When dry, the prints fall off of their own accord or will peel off readily if a corner is loosened with a knife. Brown stains sometimes appear on the surface of ferrotyped

prints, due to insufficient rinsing of the print or the tin. A damp cloth will wipe this dirt away without affecting the gloss. Insufficient washing will leave hypo in the print which turns yellow and cannot be remedied. Grains of dirt or bits of gelatine stuck to the tin produce little holes in the print which cannot be remedied. Ferrotyping on glass produces a waxy looking surface which is anything but desirable. Cleaning with benzene, soaking and referrotyping on a tin will produce excellent results.

Toning

There are two relatively simple methods of sepia toning depending for their action on the conversion of the silver image to silver sulphide. By bleaching the regular bromide print in a solution of Potassium Ferricyanide and then redeveloping the bleached image in Sodium Sulphide very excellent sepia tones may be obtained. The bleaching solution will keep indefinitely and is as follows:

Water (cold)	**32 ounces**	**1 liter**
Pot. Ferricyanide	**200 grains**	**14 grams**
Pot. Bromide	**200 grains**	**14 grams**
Liquid Ammonia	**20 drops**	**20 drops**

When prints have been fixed, wash thoroughly to remove any trace of hypo; prints on rough surface papers should be thoroughly dried before bleaching, others may be bleached without intermediate drying. Bleach until the image is but faintly visible. Wash all the yellow stain away under the tap and redevelop in the following:

Water	**32 ounces**	**1 liter**
Sodium Sulphide	**200 grains**	**14 grams**

Redevelopment takes but a minute, after which the print should be thoroughly washed and dried. To obtain Brown-Black tones do not bleach completely. Dilute the bleaching bath 5 to 1 to facilitate even bleaching and rinse off when the image is about half bleached.

The second method depends on the action of alum on hypo to form the sulphide. The bath is made up as follows:

Water	**32 ounces**	**1 liter**
Hypo	**4 ounces**	**100 grams**
Alum	**1 ounce**	**30 grams**

The above solution is milky in appearance and should not be filtered, but before use it must be ripened to avoid bleaching the prints. Toning is done between 90° and 115° F. taking from 30 to 60 minutes.

The bath may be ripened by toning three or four old discarded prints or by the addition of the following:

Silver Nitrate	**8 grains**	**0.5 grams**
Common Salt	**8 grains**	**0.5 grams**
Water	**2¼ ounces**	**70 cc**

Toning may also be carried out in the cold solution, taking from 6 to 24 hours. An excellent plan is to keep a bath in the dark room at all times and tone all discarded prints as well as those which it is purposely planned to tone. By using the cold solution the process is fool proof, toning being even throughout the print if it is first moved about to insure even wetting. The prints may be left in the bath almost indefinitely without harm. By toning discarded prints, many unusual things will be discovered.

Those prints which it is planned to tone should be printed slightly darker than is desired as the toned print is several shades lighter than the

black and white original. If the hypo alum bath is not ripened the first few prints will lose their delicate details.

There are numerous other methods of toning to obtain different colors, but their use is not recommended to the beginner. Many manufacturers issue pamphlets, obtainable through their dealers, describing these processes.

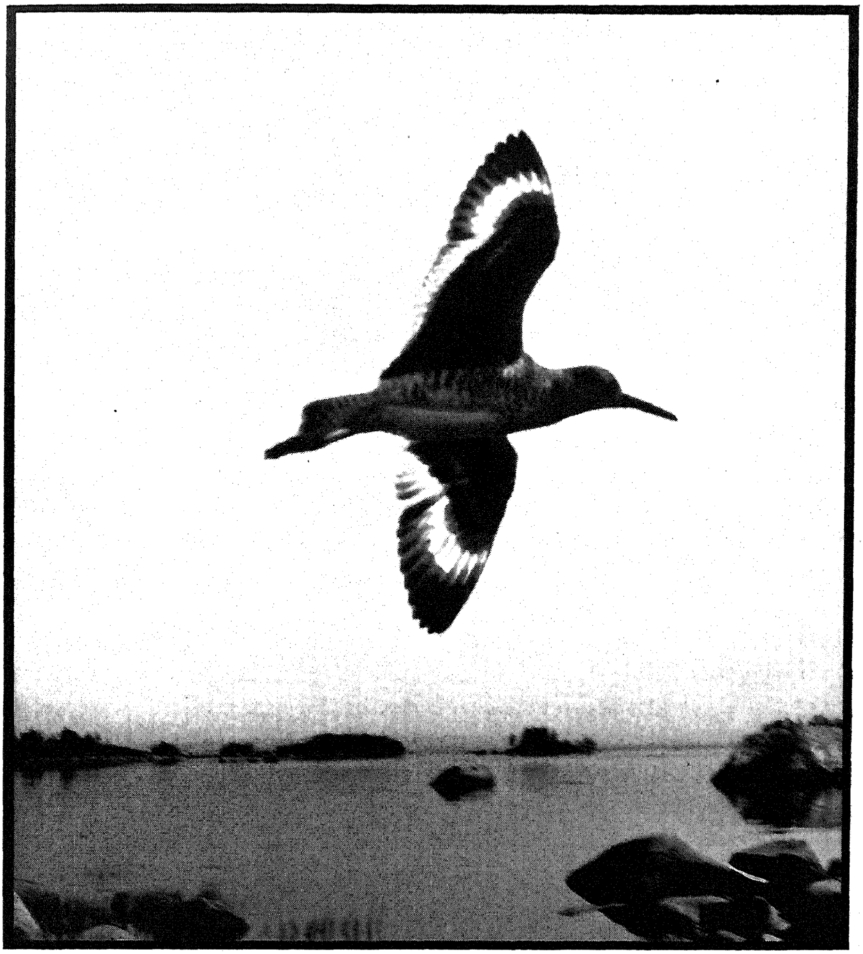
Spotting

Miniature camera work requires great care and cleanliness in every step of the process, including the storing of the negatives and their handling during inspection or use. However, no matter how much care is exercised, prints will show occasional dust spots and more rarely, dark spots, due to pin holes or minute scratchings in the film. The removal of the latter is difficult, being impossible on glossy prints and requiring very delicate use of the retouching knife on matt and semi-matt prints. Spotting the former is not so difficult with a little experience.

The hardest part of spotting prints is to find a pencil, crayon or paint which will match the print not only in color but also in gloss. Pencils are effective only on a matt or rough surface where the slight gloss of a pencil closely matches that of the paper. For most papers with matt surfaces, the carbon type pencils, which have almost no gloss at all, are very satisfactory. On the semi-matt papers ordinary soft retouching pencils are often quite satisfactory. For sepia toned prints on semi-matt surfaces, sepia crayons can be used. Fine spotting brushes with Chinese India Ink are very satisfactory if the tones of the print are real black, such as obtained from contact paper when very little bromide has been used in the developer.

For really good results on all kinds of papers, a medium such as paint which is flexible both as to color and gloss is necessary. The one drawback to paint, however, is the fact that for single prints or even to spot less than say half a dozen prints at one time, it is necessary to go to considerable bother in preparation. Some spotting colors are available on glazed paper cards but the most satisfactory method is to obtain artist's water colors, coming in tiny trays. Three colors are really necessary, lamp black—dull, blue black—dull, and burnt sienna—slightly glossy. For mixture with the above to obtain the necessary gloss a tube of Talen's blackish and another of Talen's brownish should be obtained. The total cost of the above, together with a good spotting brush, would be about two dollars and would last for many years.

Using a small bit of opal glass for a palette, carry a bit of the dull color on your wet finger to the glass. To this should be added



Willett Albert Simmons

some of the glossy color, until, as mixed with the finger on the glass, the color appears to be slightly more glossy than the print. Some experimenting will be necessary before the right sheen can be recognized, but it should always be remembered that the dull paints have less sheen than has the roughest matt paper, with the possible exception of such special finishes as Gevalux. Moisten the brush with a turning motion in a drop of water on the palette, wiping off any excess water with the same turning motion on a bit of photographic blotter, still turning the brush in the same direction, take up a bit of the mixed color and apply to the print in very small dots. Do not attempt to finish the job in one operation, keep the dots separated, letting them dry while working on a different portion of the print and then coming back, several times if necessary, to fill in the spaces between the dots. If the brush is not too wet and if the minimum amount of water has been used in mixing the colors, it will be found that by *very* light strokes nice even dots can be made which will not smear or vary appreciably in color when dry. The smallest pin holes appearing in a print usually require about three of these fine dots to be properly concealed. If it is attempted to put one large dot in these holes, the paint will dry in a little lump which will usually rub off after it has dried. In using an etching knife to remove dark spots, such as are caused by pin holes in the negative, it will usually be found most successful to carry the operation a shade beyond the adjoining tones, spotting with the proper color so as to obtain the right gloss, since on glossy prints any knife work leaves a matt surface and on matt prints knife work leaves a semi-gloss surface.

Another method of spotting matt prints, particularly suitable for portrait work, or where large areas are to be covered, such as working in backgrounds or clouds, is the use of chalks. These can be obtained in blocks from artists' supply stores or can be prepared at home from the filing obtained when sandpapering retouching pencils to a fine point. The only things which must then be bought are stumps and pumice powder (used by draughtsmen on tracing cloth for making the ink hold and obtainable from most artists' supply stores). Excellent stumps can be made at home after a little practice by rolling lengths of paper on a diagonal so as to obtain different sized points. However, soft chamois and paper stumps cost little.

The print is first rubbed lightly with pumice to eliminate any possible grease and the chalk, mixed with a little pumice, is then rubbed on and worked with a stump to the necessary shade. For

large areas, such as working in backgrounds or clouds, a ball of cotton dipped into the mixture of pumice and chalk is used to cover the area, the larger stumps then being used to work in the shading and detail. In working in backgrounds a soft eraser can be used to break the outline in long slanting strokes, a soft bit of clean cotton then being used to soften the edges of the breaks and smooth out the outlines. Some experimenting and a considerable study of studio portraits will be necessary before really good work of this sort can be done. To fix the chalk to avoid rubbing, etc., provide a large tray of water. The tray should be considerably larger than the print and should contain about 2 inches of water, more if possible. Holding the print by both ends, give it a considerable curve and in one movement draw it into the water, to the bottom of the tray and out at the other end of the tray. Allow the water to drain off one end and without shifting the position of the print hang it up to dry. Streaks will appear if the movement of the print through the water is jerky or if the print is moved around while the water is draining off.

When Matte and Semi Matte Papers are used a light coating of wax often lends a beautiful luster to the print. Waxing preparations may be obtained from your dealer. In applying them it is best to use a small pad of cheesecloth to apply a little wax over the entire print, then quickly rubbing off the excess with a clean cloth. Some preparations require considerable time to dry; others can be handled within an hour. The bottle should give all necessary information.

Presentation of the Finished Prints

One phase of photography which is almost totally ignored by the average worker, is the presentation of his print. Not that the frame is required to appreciate the beauty of a picture, but it does help considerably. The average album of snapshots is undoubtedly the best illustration of the worst method of presenting prints. If the prints are to be mounted in albums, considerable thought should be given to the size of the prints, the widths of their borders, and the color of the stock in comparison with the size and color of the album. Prints in black and white do not show up effectively on buff or ivory stock nor are they as effective in an album the pages of which are of buff or have a brown tone. They should be mounted, preferably, on white or gray. Similarly, buff prints or sepias look their best against the background having brown or buff tones. The mounting of the prints in the album should be tasteful rather than convenient. The use of tissue, black, brown or white, under the print and showing

a narrow edge, is very effective. After some experience, the amateur with a taste for modern contrasts will learn to use tissues of such striking colors as red or blue.

For prints to be shown separately, mountings on heavy stock are to be recommended. The simplicity and taste which is shown in the choice of the stock and the method of mounting will be the key-note of its success, yet it is a relatively simple matter to prepare such mountings.

Embossing Prints

The simplest of all is the embossed print. For this, it is necessary to carefully plan the print so that no trimming of the picture is necessary. Sufficient border is left to properly frame the finished picture, somewhat more at the bottom than at the top and sides. A piece of card is then chosen, about the same thickness as the stock or slightly thicker; this is trimmed the same shape as the picture but a trifle larger. If a heavy glass plate is available a light is placed under it, the card just trimmed laid on that and the picture placed face down over the card and adjusted to leave an equal border around the picture. With an embossing tool, the back of a tooth brush or knife handle, the stock is rubbed equally all around the edge of the card, causing the picture area, when viewed from the face, to be sunk behind the border. Many variations will suggest themselves to the imagination, such as beadings, double borders, etc. The print thus embossed may then be trimmed to equalize the borders. The edges may be roughened by laying the print on the table with the edge out to the table edge and scraping with a sharp knife.

In cutting the card so as to make window mounts, cut from the back and against a hard surface so as to leave a smooth edge. To cut on an angle, lay a steel or other thin ruler under the knife, holding the knife firmly and keeping the blade of the knife and the nail of the index finger firmly against the guide—thus maintaining a constant angle.

The final step in mounting, particularly for Christmas cards, is the book or folder. The print may simply be placed in the folder, or a card mount nicely embossed, or again a window mount may be prepared and the whole placed in the folder. The folder preferably should be of lighter material than the card used as a mount in the last two cases, although like everything else, this is really a matter of taste and individuality. A tissue paper fly leaf may or may not be inserted. The cover may have some design embossed into it or

may be printed with a linoleum or wood block. Any number of variations suggest themselves and much pleasure will be derived from making individual mounts.

One word about pasting. Library paste, homemade paste and any glue will do the job. Some contain products which will injure a photograph, but most are quite satisfactory. However, for a neat and convenient, as well as reliable job, nothing is as satisfactory as dry mounting tissue. A hand iron, kept nicely warm, or if of the automatic type, set at a low heat, is just right for mounting pictures up to 11″ by 14″ and the thinnest mounts will lie flat.

Rubber cement is probably the best and the cleanest mountant. It should be spread with a large brush over both the mount and the print and allowed to dry for more than a half hour. The print must then be carefully adjusted to guide marks previously made on the mount, for once placed it will be impossible to move the print. Any excess cement around the edges can be removed with a soft cloth. Do not get rubber cement on waxed prints as it removes the wax. When using paste glue or cement the mounted print should be placed under light pressure for a short while before putting in a press or under heavy pressure for final drying. When transferring from the light to the heavy pressure a careful inspection should be made to be sure no paste or cement has oozed out at the edges of the print.

Many advanced workers are using thin papers for paper negatives; a beautiful result can be obtained by printing on the thinnest papers available and carefully mounting on medium weight mounts. This is particularly satisfactory for Christmas cards. Thin papers must be treated carefully to avoid air bells in the developer and hypo.

And so a little has been said regarding many things. Perhaps a first reading has confused some or led others to believe that the whole matter is unnecessarily involved. I hope, however, that in some way many who have read this chapter will become more keenly appreciative of the importance of printing as one of the major steps in producing a photograph; far too little has been said to date regarding this angle of photography, each newcomer apparently being expected to struggle along until somehow he succeeds in turning out one or two good prints from each package of paper he buys. **If, as has been stressed several times before, the beginner will stick to one paper, one developer, etc., until he is turning out a fair average of good prints, he should find that he has learned to do this with very little waste of paper and time.**

Fig. 118 A Dandelion Gone to Seed...Photo by Wm. M. Harlow

135mm Elmar lens, f:36, 5 seconds, Panatomic. Sliding Copy Attachment used.

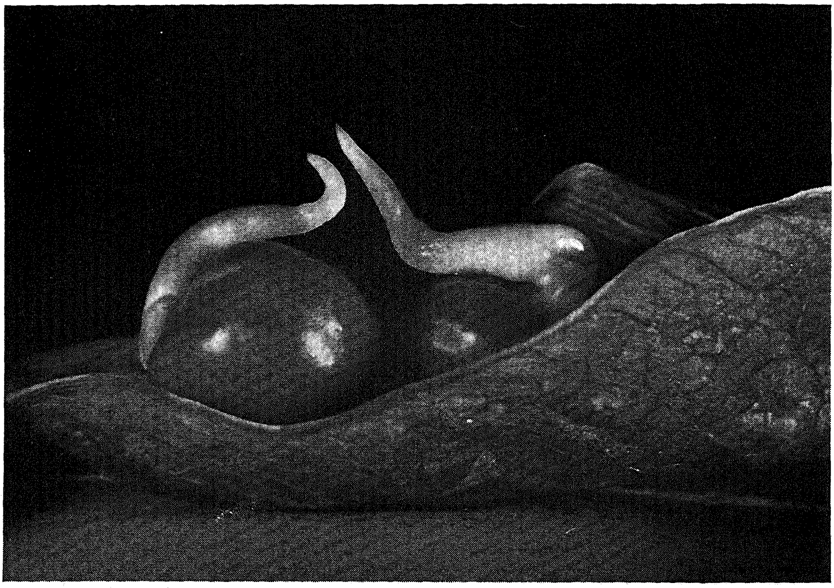


Fig. 119 Sprouting Peas J. M. Leonard

COPYING AND CLOSE-UP PHOTOGRAPHY

WILLARD D. MORGAN CHAPTER 9

Data Tables by Henry M. Lester

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In ordinary use the Leica cannot be adjusted for photographing objects at distances less than 3½ feet without the aid of special supplementary front lenses or one of the copy attachments. Thus the 3½ foot mark becomes the dividing line or norm for the Leica user who is interested in photographing large or small objects. Let us step across the threshold of this 3½ foot mark and explore the wonders of the world of small objects. What a contrast! In the large object field we were photographing people, buildings, mountains, and even the moon or sun far out into the space of infinity. Yet in the small object world there is a universe in itself to be explored by the inquisitive mind. Here a book page may be copied or a micro-organism photographed on the Leica negative with a 2,000 times magnification. A truly amazing contrast from infinity to 2,000 times magnification. The user of a Leica can readily span this gap.

Intensive work in photographing the large object world has been carried on for nearly a century. However it has only been in recent years that small object or micro photography has become an essential part of our daily living, mainly because of the important advances in camera design. The eye of the camera was made to peer into the inner structure of the world. All the large hospitals and educational institutions have elaborate photographic departments equipped for the close-up micro photography of specimens which are invaluable for future reference by the medical and teaching staff. Police departments use the camera for close up photography just as nimbly as they use their guns. Industrial firms keep constant photographic records of their products which may be used for reference, sales, or advertising purposes. The visual education field is an important user of close up or small object photography for presenting thousands of different subjects on the projection screen or by actual photographs to millions of students. Such examples show

us how immense and likewise important the field of small object photography has become. Let us now learn how to use our Leica camera for this type of work.

Practically everyone who uses a camera has had the occasion to make close-up photographs of objects. Such pictures may have been more or less successful depending upon the camera and experience of the operator. The copying possibilities of a camera should really be looked upon as the visual note book which is indispensable for keeping accurate records of any object, such as machine parts, drawings, manuscripts, geological specimens, medical subjects, or small magnified pictures of insects. In fact it may be said that anything can be copied that can be illuminated adequately for photographic purposes.

If you are a student the copy camera outfit can quickly be applied for illustrating your biology note book, or possibly you may need references from rare books which can not be removed from the library. In the latter case the camera can be utilized perfectly and at a minimum expense. The developed negatives may be placed in a projector or enlarger and read directly from the projected image.

Importance of Small Object Photography

This chapter on Small Object Photography should be studied carefully because it is the basis upon which other chapters have been prepared. A thorough knowledge of the copying equipment and methods will enable you to grasp a complete understanding of the following chapters which are so closely related to the present chapter:

A. The Leica as an Ophthalmic Camera.
B. Miniature Camera for Miniature Monsters.
C. Making Leica Film and Glass Slides.
D. Dental Photography with the Leica.
E. Photomicrography with the Leica.
F. The Leica in Visual Education.
G. Historical Research with a Leica.

Close up photography of small objects really has a field and technique quite different from the usual type of photographic work which is practiced by everybody who can focus a camera and click the shutter. When we start taking photographs of a butterfly, newspaper clipping, flower, mineral specimen, or any small object, a number of special problems arise.

1. The camera requires additional equipment.
2. Focusing becomes more critical as depth of focus decreases.
3. Exposure factors change and are calculated according to the degree of magnification required.
4. Proper illumination becomes an extremely important problem.

5. It is often necessary to use color filters in order to obtain certain results.
6. The Leica camera and auxiliary equipment must be mounted on a rigid base, free from vibration.
7. The proper film must be selected for use with the various types of copy work.
8. Even the specimens to be copied should be mounted or properly arranged in order to insure a perfect reproduction on the negative. As the final picture will be reproduced in black and white, or monotone, it is important to select objects which will produce the best contrasts and details required.

As most of us are not equipped with spacious photographic studios our camera equipment should be small, light, and easily portable.

Even the developing technique is of great importance for films made of small objects.

Once the proper equipment has been assembled for any type of close up photography there will be many interesting objects to photograph. In fact you will begin to see a new world in miniature.

Accessories for Close Up Photography

There are a number of accessories provided for covering every possible demand which may arise for the Leica user who wishes to use his camera for copying. Each copy attachment will be individually described in order to present the features of each one in such a way that the Leica worker may easily make the proper choice to fit any special requirement.

Sliding Focusing Copy Attachment

Shortly after the introduction of the Model C Leica with the interchangeable lens feature in the Fall of 1930 I started experimenting with the use of various extension tubes placed between the camera and lens. These extension tubes actually take the place of the familiar long extension bellows to be seen on the larger view cameras. My results for this type of close-up copy work were very encouraging and I saw the possibility of developing a new field for Leica users. Following the work with the metal extension tubes I designed the first Sliding Focusing Copy Attachment which has since been manufactured and distributed to thousands of Leica users during the last few years.

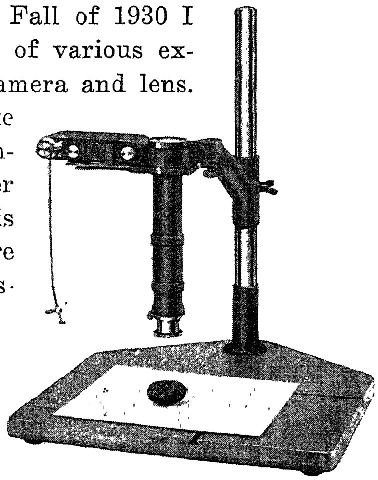


Fig. 120 Sliding Focusing Copy Attachment (Fuldy) Set-up in Position for Copying

Basically the Sliding Copy Attachment, also known as the Fuldy Copy Attachment, consists of two metal plates, one for attaching to the camera and the other for holding the lens and extension tubes. On the part which holds the camera there is a ground glass with a masked out area equal to the size of the Leica negative. This ground glass screen is in exactly the same plane as the film in the Leica camera. Therefore when the image of the object being photographed is in sharp focus on the ground glass it will also be in perfect focus when the camera is moved into the same position directly over the lens.

The Fuldy Copy Attachment has been designed for use in any position required for photographing either horizontal or vertical subjects. A tilting top or Ball Jointed Tripod head may be used for securing this attachment to a tripod for indoor or outdoor use. A special bolt can be secured for inserting into the hole of the Sliding Arm which is also used for holding the rod of the illuminating bracket. When this bolt is in position the Leica or the copy attachment can easily be secured in a horizontal position for photographing such objects as the human eye, maps on a wall, or mounted specimens. In fact after a little experience with the Sliding Copy Attachment it will be found that any photographic angle may be quickly secured.

Around the focusing plate there is a clip mount for attaching the special magnifier which is of value when obtaining extremely critical focus. Once the Leica is attached to the sliding plate of the Fuldy accessory it can readily be reloaded at any time without removing from this plate. A Wire Release must be used for releasing the shutter in order to avoid any possibility of jarring the camera at the time of exposure.

Description of Sliding Copy Attachment Parts

The accompanying illustration gives complete information about the various parts of the Fuldy Copy Attachment. This copy attachment is adapted for use with the various Leica models which have the interchangeable lens feature. Owners of the early Model A Leica can have their cameras converted so that the lens will be detachable, for use on this attachment as well as for the Leica enlarger and projector.

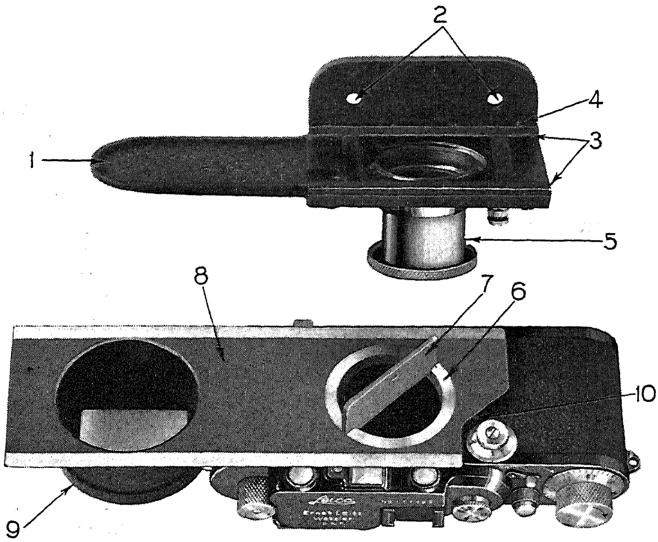


Fig. 121 Essential Parts of the Sliding Focusing Copy Attachment

1. Light shield to prevent stray light from entering camera opening while focusing.
2. Threaded opening for securing the attachment to a tripod, extension arm of the reproduction stand, or the Sliding Arm for use with the upright pillar of the Leica enlarger.
3. Dove-tail groove into which the sliding plate (No. 8) moves while focusing and making exposures.
4. Stop for use when changing from focusing to photographing position.
5. Leica lens screwed into position.
6. Clamping ring for holding the Leica camera securely to the sliding base plate.
7. Key for turning clamping ring (No. 6).
8. Sliding base plate for holding the Leica camera, focusing ground glass, and also the magnifier.
9. Focusing ground glass in exact plane with the film in the camera. There is also a place to attach the magnifier when necessary.
10. Space cut from the sliding plate (No. 8) to permit the Model F or G Leica camera to fit properly.

The Fuldy Attachment in Use

The Fuldy device may be set up as follows:

A. Attached to the Sliding Arm which is secured to the upright column used for the Leica enlargers.

B. Mounted on the Collapsible Reproduction Stand.

C. Secured to a ball jointed or tilting top tripod head which in turn is attached to a firm support such as a tripod.

Before the set up is complete the subject to be copied must be placed into position and properly illuminated. Finally the correct focus is determined by moving the camera close or away from the object. Fine focusing is obtained by using the focusing mount on the lens, or in the case of the 50mm lenses the lens barrel is moved back and forth in its mount. Once perfect focus has been secured on the ground glass the camera is slid into position ready for making the exposure. Stop the lens down as far as practical after focusing and before making the exposure.

When the regular 50mm Elmar lens is used on the Fuldy Attachment directly without the use of additional extension tubes it is possible to photograph any object which comes within the maximum area of 15 x 20 inches and a minimum area of 4 x 6 inches simply by moving the lens mount in or out and setting the camera in the proper position. On account of the sliding feature of the Fuldy Attachment it is not possible to collapse the lens far enough for including greater areas than 15 x 20 inches without resorting to a special adjustment which extends the usefulness of the attachment up to any limits including infinity. To obtain such areas proceed as follows:

1. Place a rubber ring (such as the ring supplied with the Micro Ibso Attachment) around the barrel of the 50mm lens.
2. Slowly push the lens barrel into the mount until the image is sharply in focus on the ground glass. The rubber ring will then be flush with the base of the lens mount, and thus mark the exact position where the lens is in focus. In this position the lens barrel projects into the attachment and thus prevents the upper sliding plate from moving.
3. After exact focus has been secured pull out the lens barrel, slide the camera into position, and push the lens barrel back to its proper position now accurately marked by the thick rubber ring.

This method of securing photographs of larger areas is seldom required because the majority of subjects copied are much smaller and may be copied in the regular way with the Fuldy Copy Attachment.

The Extension Tubes

In order to secure proper focus at the higher magnifications it is necessary to move the Leica lens away from the film plane. Instead of using a cumbersome bellows similar to the larger view cameras for holding the lens in proper position I designed the 12mm, 30mm, 60mm, and 90mm metal extension tubes for this purpose. With such a set of tubes together with one of the collapsible 50mm lenses, any combination can be secured to obtain the proper magnification and focus upon an object which might be as small as a pinhead. Such tubes are small and light and keep the lens in a rigid position at all times.

When the Fuldy Attachment is used with the 30mm tube and the 50mm lens natural size or 1:1 pictures may be made. By pushing the lens barrel into its mount additional areas may be covered. The 60mm tube is very useful for securing slightly higher magnifications and also for use when the Fuldy Attachment is used with the microscope. An unusually long set up of extension tubes may be seen in the arrangement for insect photography illustrated in J. M. Leonard's chapter.

The introduction of the Sliding Focusing Attachment in connection with extension tubes of various lengths greatly increased the Leica's usefulness. Every day new fields are being reported where the application of these accessories was at first found useful and later became indispensable.

1. Twig and buds of sugar maple showing bud scales and bud scars.
2. Flower bud of flowering dogwood.
3. Leaf bud of flowering dogwood showing valvate scales.
4. Naked bud of wayfaring tree.
5. The leaf scar covers the bud.
6. Stipule scars appearing as a line encircling the twig.
7. Twig and buds of butternut showing a leaf scar, bundle scars, and superposed buds.
8. Collateral buds.
9. Leaf scar and stipule scars.
10. Pseudoterminal bud and branch stub of red mulberry.
11. Thorn.
12. Stipular spines of black locust.
13. Pseudoterminal bud and branch scar of basswood.

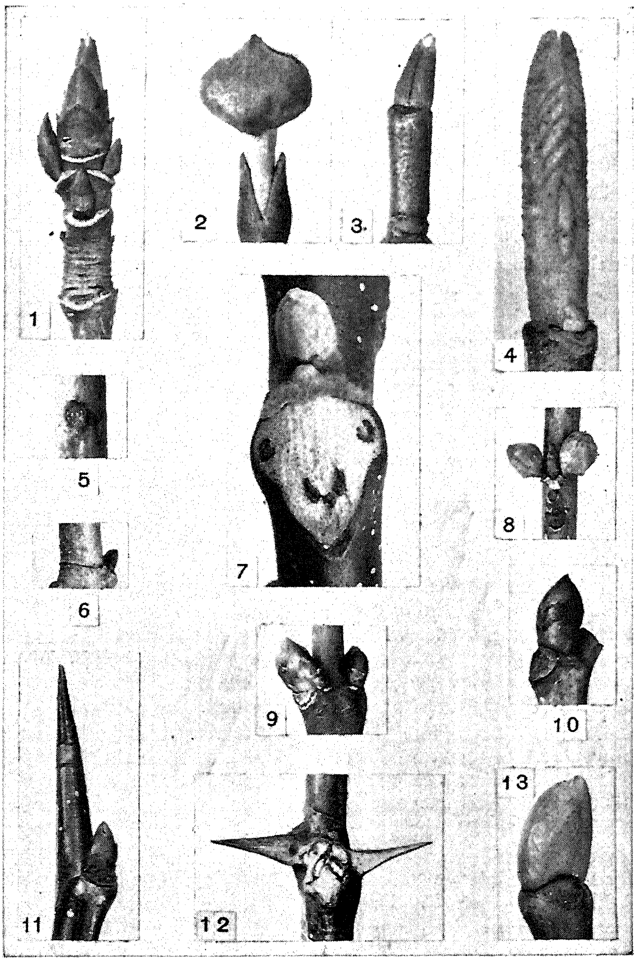


Fig. 122. Twig and Bud Photographs by Wm. M. Harlow

During the Winter months the leafless trees in our forests or parks have very reliable marks of identification on their very "finger-tips" or twigs. Dr. Harlow uses the Sliding Focusing Copy Attachment for securing interesting close-up photographs of these buds. Here is a field of photography which is extremely interesting and many Leica users can apply their knowledge of copying very successfully.

Most of the information concerning the use of these accessories was available for the 50mm lenses because they are the most popularly used. It will be found however that lenses of longer focal length are extremely useful for certain types of work. In order to facilitate and simplify the use of these accessories with any of the Leica lenses and tubes the Editors now offer for the first time a new table and some basic formulas which will enable the average worker to determine certain important factors for the different lenses and extension tubes without resorting to tedious experimental or mathematical work.

The table given on pages 198, 199 was computed for the 50mm lenses (either Elmar, Hektor, or Summar). This table should be consulted not only for information regarding the use of these three lenses, but also as an example of information that can be obtained by the use of the few simple formulas which follow.

It should be noted that the figures contained in this table referring to the depth of focus are based upon the diameter of the circle of confusion being .03mm (approximately 1/750 of an inch). This is the only part of the table which is affected by the size of the circle of confusion. Should a smaller circle of confusion be required, or a larger one be found sufficient, the data given in the table should not be used, but other figures computed with the aid of the formulas appended.

The 135 mm Lens Mount

Still another method of securing focus for objects at any distance up to infinity, when using the Fuldy Attachment, is by using the special 135mm lens mount which is 11mm shorter than the regular mount for this lens. In other words this mount is made to compensate for the 11mm displacement of the lens in the Focusing Copy Attachment. (This mount may be ordered through any Leica dealer in the United States.)

The 135mm lens is easily unscrewed from its standard mount and placed in the shorter mount for use on the Fuldy Copy Attachment. With this mount in place the copy attachment is excellent for use in taking portraits or any other subject which can be focused upon the ground glass.

The special 135mm mount is supplied with a reducing ring for attaching the 50mm lenses. By using this set-up it is possible to secure fine focusing simply by turning the focusing mount of the 135mm lens barrel. Additional extension tubes can be attached when required to secure higher magnifications.

Fig. 123 Latent Finger Print on Black Rubber Surface... Gray Finger Print Powder. Photo by Ira Gullickson. Sliding Copy Attachment, used with 30mm tube

Use of Extension Tubes Directly on the Camera

Without Sliding Focusing Attachment

It is frequently desirable to use various Extension Tubes or their combinations directly on the camera, without the use of the Sliding Focusing Attachment. This is quite practicable. The tube is simply screwed into the camera and the lens is screwed into the tube. Such an arrangement sometimes can be used in lieu of auxiliary front lenses. The focusing is then done to scale. Great accuracy is an absolute prerequisite of success.

The following table is given for this type of work.

It is based upon the diameter of Circle of Confusion of 0.03mm.

Since it is impossible to compose the picture on the film visually it is recommended to use a plumb weight whenever this method is employed. Special plumb-weights are available, but any plumb-weight will be found to work as long as it will be made so that it will drop in a line with the optical axis of the lens.

WORKING DISTANCE, RATIO OF MAGNIFICATION, DEPTH OF FOCUS, EXPOSURE FACTORS AND FIELD OF COVERAGE FOR EXTENSION TUBES USED DIRECTLY ON LEICA CAMERA (without Sliding Focusing Attachment) with ALL 50mm Leica Lenses:

Elmar f:3.5 Hektor f:2.5 Summar f:2

Total Length in Millimeters	Extension Tubes MM	Working Distance (from object to Lens) in MM	Depth of Focus at f/12.5 Nearest points in focus in Millimeters	Farthest	Exposure Factor (Increase in exposure) (Times)	Approximate Field Covered in MM	Ratio of Reduction or Magnification
12	12	259	251	267	1.5x	96 ×144	4:1
22	22	164	161.5	167	2.0x	54 × 81	2.25:1
30	30	133	131.3	134.7	2.5x	38 × 58	1.6:1
42	12+30	109	108.2	110	3.4x	29 × 43	1.2:1
60	60	92	91.6	92.7	4.8x	20 × 30	1:1.2
72	60+12	85	84.6	85.5	6.0x	16 × 24	1:1.5
90	90	78	77.7	78.4	7.75x	13 × 20	1:1.8
102	90+12	74.5	74.3	74.8	9.25x	12 × 18	1:2
120	90+30	71	70.8	71.2	11.5x	10 × 15	1:2.4
142	90+30+12	69	68.8	69.2	14.75x	9 × 14	1:2.6
150	90+60	66.6	66.4	66.8	16.0x	8 × 12	1:3
162	90+60+12	65.5	65.4	65.7	18.0x	7.5 × 11	1:3.25
180	90+60+30	64.0	63.9	64.1	21.0x	6.7 × 10	1:3.6
192	90+60+30+12	63.0	62.9	63.1	23.5x	6.25 × 9.35	1:3.85

Fig. 124 Photo of Herbarium Sheet by Carl B. Wolf. An example to show the use of the Leica Copy Equipment in one particular photographic subject.

Fig. 125 Writing Showing Shading Variations in Pen Pressure and Grain of Paper. Elmar 50mm Lens with Focusing Copy Attachment

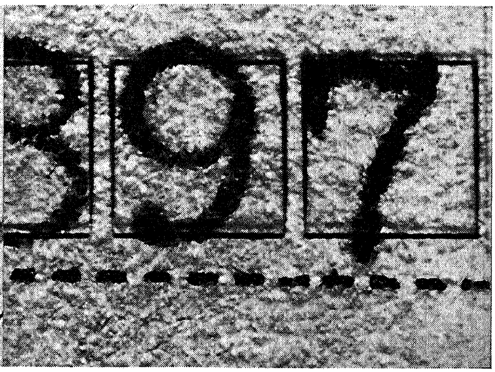


Fig. 126 Copy of Typewriting...by Ira Gullickson. Pica type, ruled square on glass over typing. Fine detail shows type and kind of paper. Printer's ink in dotted line seen as being different from typing. Fuldy Copy Attachment with Elmar 50mm lens, 30 and 60mm tubes.

Exposure Factors

For ALL Extension Tubes When Used With Various Leica Lenses and the Sliding Focusing Attachment

Tubes Lenses:	35mm	50mm	73mm	90mm	105mm	135mm
11mm	1.75x	1.5x	1.33x	1.26x	1.21x	1.08x
12mm	1.8x	1.54x	1.35x	1.28x	1.24x	1.09x
22mm	2.65x	2.1x	1.7x	1.5x	1.46x	1.35x
30mm	3.45x	2.55x	2.0x	1.78x	1.65x	1.5x
60mm	7.5x	4.8x	3.3x	2.75x	2.45x	2.1x
90mm	12.8x	7.8x	5.0x	4.0x	3.45x	2.75x
*Special Focusing Tube: *Shortest Adjustment:* 81mm	11.0x	6.8x	4.5x	3.6x	3.1x	2.55x
*Special Focusing Tube: *Longest Adjustment:* 97mm	14.2x	8.6x	5.4x	4.3x	3.7x	2.95x

* This Extension tube was originally designed to permit the use of the 135mm lenses in connection with the Sliding Focusing Attachment. It is actually a *sawed-off* 135mm lens mount. The 135mm lens is screwed into this tube. In this form it can be used on the Sliding Focusing Attachment even at infinity: the calibrations having been retained.

A special threaded collar is supplied with this tube which permits the use of any other Leica lens. However lenses other than 135mm cannot be used for infinity focus in connection with this tube. These lenses are used merely for extreme magnifications, in which case this tube becomes a convenient adjustable extension tube.

This table of Exposure Factors for all tubes and all Leica Lenses will be found useful for ascertaining the correct exposure factors:

1. when using extension tubes directly on the camera (without Sliding Focusing Attachment), interposing them between the camera and any lens.
2. when using various extension tubes or their combinations in connection with Sliding Focusing Attachments and any Leica Lenses.

For the purpose of exposure factors the Sliding Focusing Attachment is considered just as any other tube of 11mm length. Every tube, depending on its length, has its own exposure factor, which is constant for every lens.

TABLE OF DATA FOR COPYING OR REPRODUCTION WITH LEICA CAMERA, SLIDING FOCUSING ATTACHMENT AND EXTENSION TUBES FOR ALL 50MM LENSES: SUMMAR, HEKTOR OR ELMAR

Distance From Object to Lens	Distance From Lens to Film Plane	Ratio of Reduction or Magnification	Depth of Focus at F:6.3, Diam. Circle of Confusion .03mm: Nearest Point in Focus	Depth of Focus at F:6.3, Diam. Circle of Confusion .03mm: Farthest Point in Focus	Exposure Factor (Increase of Exposure)	Approximate Field Covered	Auxiliary Reproduction or Copying Equipment S.F. A. =Sliding Focusing Attachment	Position of Lens
B	D	R. or M.	A	Z	T			
Formula 4B	Formula 4D	Formula 3	Formula 5A	Formula 5Z	Formula 2			
Millimeters	Millimeters	Ratio	Millimeters	Millimeters	Times	Millimeters		
1000	52.6	19 :1	928	1076	1.1x	456 ×684	None	Lens directly on camera Focusing set for nearest distance
800	53.3	15 :1	756	849	1.15x	360 ×540	S.F.A. No tubes	Lens barrel unlocked, moved in and out for focus
600	54.5	11 :1	576	626	1.18x	264 ×396	S.F.A. No tubes	Lens barrel unlocked, moved in and out for focus
500	55.5	9 :1	484	517	1.23x	216 ×324	S.F.A. No tubes	Lens barrel unlocked, moved in and out for focus
400	57.1	7 :1	389	412	1.3x	168 ×252	S.F.A. No tubes	Lens barrel unlocked, moved in and out for focus
350	58.3	6 :1	341.4	358	1.37x	144 ×216	S.F.A. No tubes	Lens barrel unlocked, moved in and out for focus
300	60.0	5 :1	294.5	305.5	1.45x	120 ×180	S.F.A. No tubes	Lens barrel unlocked, moved in and out for focus
277	61.0	4.5 :1	272.5	282	1.5x	108 ×162	S.F.A. No tubes	Lens mount set for ∞ lens barrel locked in mount
250	62.5	4 :1	245.6	254.2	1.56x	96 ×144	S.F.A. + 12mm tube	Focus with lens barrel

200	66.6	3 :1	197.5	202.5	1.76x	72 × 108	S.F.A. + 12mm tube	Focus with lens barrel
175	70.0	2.5 :1	173.1	176.8	1.95x	60 × 90	S.F.A. + 12mm tube	Focus with lens barrel
159	73.0	2.25 :1	157.8	160.3	2.15x	54 × 81	S.F.A. + 12mm tube	Lens mount set for ∞ lens barrel locked in mount
150	75.0	2 :1	148.7	151.2	2.25x	48 × 72	S.F.A. + 22mm tube	Focus with lens barrel
125	83.3	1.5 :1	124.2	125.7	2.75x	36 × 54	S.F.A. + 22mm tube	Lens locked in mount set for ∞
110	91.0	1.25 :1	109.5	110.6	3.33x	30 × 45	S.F.A. + 30mm tube	Lens locked in mount set for ∞
100	100.0	1 :1	99.5	100.4	4.00x	24 × 36	S.F.A. + 12mm & 30mm tube	Focus with lens barrel
97	103.0	1 :1	96.7	97.4	4.25x	24 × 36	S.F.A. + 12mm & 30mm tube	Lens locked in mount
85	121.0	1 :1.5	84.8	85.3	5.86x	16 × 24	S.F.A. + 60mm tube	Lens locked in mount
80	133.0	1 :1.75	79.8	80.3	7.0x	13.5 × 20.5	S.F.A. + 60 & 12 tube	Lens locked in mount
75	151.0	1 :2	74.83	75.25	9.0x	12 × 18	S.F.A. + 90 tube	Lens locked in mount
72	163.0	1 :2.25	71.85	72.2	10x	10.5 × 16	S.F.A. + 90 & 12 tube	Lens locked in mount
69	181.0	1 :2.5	68.86	69.10	13x	9.6 × 14.6	S.F.A. + 90, 30 tube	Lens locked in mount
67	193.0	1 :3	66.88	67.15	15x	8 × 12	S.F.A. + 90, 30 & 12 tube	Lens locked in mount
65	211.0	1 :3.25	64.88	65.10	18x	7.4 × 11.6	S.F.A. + 90 & 60 tube	Lens locked in mount
64	223.0	1 :3.5	63.89	64.14	20x	6.9 × 10.3	S.F.A. + 90, 60, 12 tube	Lens locked in mount
63	241.0	1 :3.75	62.9	63.12	23x	6.4 × 9.6	S.F.A. + 90, 60, 30 tube	Lens locked in mount
62	253.0	1 :4	61.91	62.1	25x	6 × 9	S.F.A. + 90, 60, 30, 12 tube	Lens locked in mount
61	275.0	1 :4.5	60.91	61.1	30x	5.35 × 8	S.F.A. + 90, 60, 30, 22, 12 tube	Lens locked in mount
60	300	1 :5	59.92	60.09	36x	4.8 × 7.2	S.F.A. + 90, 90, 60 tubes	Lens locked in mount
58.3	350	1 :6	58.23	58.38	49x	4 × 6	S.F.A. + 90, 90, 90, 30 tubes	Focus with lens barrel
57.1	400	1 :7	57.05	57.17	62x	3.44 × 5.15	S.F.A. + 90, 90, 90, 60, 12 tubes	Focus with lens barrel
55.5	500	1 :9	55.46	55.55	100x	2.67 × 4	S.F.A. + four 90s, 60, 22 tubes	Focus with lens barrel
52.6	1000	1 :19	52.57	52.64	400x	1.26 × 1.89	S.F.A. + ten 90s, 30, 12 tubes	Focus with lens barrel

For lenses other than 50mm similar data are obtainable with the aid of respective simple formulas.
Intermediate values, not contained in table also may be obtained with these formulas marked at head of each column.

Formulas

1. $L = \dfrac{F}{f}$ = Diameter of lens

2. $T = \dfrac{D^2}{F^2}$ = Exposure factor (increase of exposure)

3. $\dfrac{O}{I} = \dfrac{B - F}{F}$ = Ratio of reduction (As a function of the object or magnification distance)

   $\dfrac{O}{I} = \dfrac{F}{F}$ = Ratio of reduction (As a function of the image or magnification distance)

4. $F^2 = (D - F) \;.\; (B - F)$ = (Relation between focal length, object and image distance)

   $B = \dfrac{D \,.\, F}{D - F}$ = Working distance of object to lens

   $D = \dfrac{B \,.\, F}{B - F}$ = Distance of image to lens

5. Depth of focus at a given diameter of Circle of Confusion:

   $A = \dfrac{L \,.\, B \,.\, F}{(L \,.\, F) + C(B - F)}$ = Nearest point in focus

   $Z = \dfrac{L \,.\, B \,.\, F}{(L \,.\, F) - C(B - F)}$ = Farthest point in focus

Explanation of Symbols

M — Ratio of Magnification
R — Ratio of Reduction
O — Size of Object (linear dimensions)
I — Size of Image on film (linear dimensions)
B* — Distance of Object to the Lens
D* — Distance of Image to Lens
F* — Focal Length of Lens
f — Stop of diaphragm
T — Exposure Factor (increase of exposure)
C* — Diameter of Circle of Confusion
L* — Diameter of Lens
A* — Nearest point in focus when lens is focused for B.
Z* — Farthest point in focus when lens is focused for B.

* It is important to express all units of length in the same system, either metric or linear (inches).

Practical Applications

1. Diameter of Lens:

$$L = \frac{F}{f} \text{ or } \frac{\text{(Focal Length)}}{\text{(Lens Stop(f))}}$$

Example:

What is the diameter of the aperture of a 50mm lens when it is stopped down to f:12.5?

$$L = \frac{50}{12.5} = 4\text{mm.}$$

2. **Exposure Factor:**

$$\text{Increase of Exposure T} = \frac{D^2}{F^2} \text{ or } \frac{(\text{Distance from lens to film plane})^2}{(\text{Focal length})^2}$$

Example:

What is the exposure factor for a 90mm tube when used directly on the camera in connection with a 90mm lens?

$$\text{Distance from lens to film plane } \frac{[90\text{mm (tube)} + 90\text{mm lens}]^2}{90^2}$$

$$= \frac{180^2}{90^2} = \frac{32.400}{81.00} = 4\text{ x}$$

3. **Ratio of Reduction or Magnification:**

$$\frac{\text{Size of Object}}{\text{Size of Image}} = \frac{O}{I} = \frac{B - F}{F} = \frac{\text{Distance from Object to Lens less Focal length of Lens}}{\text{Focal length of Lens}}$$

Example:

Ratio of Reduction of an object 900mm from a 35mm lens:

$$\frac{900-35}{35} = \frac{865}{35} = 24.7 \div 1;$$

$$\text{say } 25 \div 1$$

or:

$$\frac{\text{Focal length of lens}}{\text{Distance from Lens to Film Plane—minus focal length of lens}} = \frac{F}{D-F} = \frac{I}{O}$$

Example:

What is the ratio of Magnification obtained when using 60 and 90mm extension tubes in connection with a 73mm lens (tubes directly on the camera—no S. F. A.)?

$$[60 + 90 + 73 \text{ (lens)}] = D = 223$$

$$\frac{F}{D-F} = \frac{73}{223-73} = \frac{73}{150} = \frac{1}{2.06} \text{ or } 1 \div 2$$

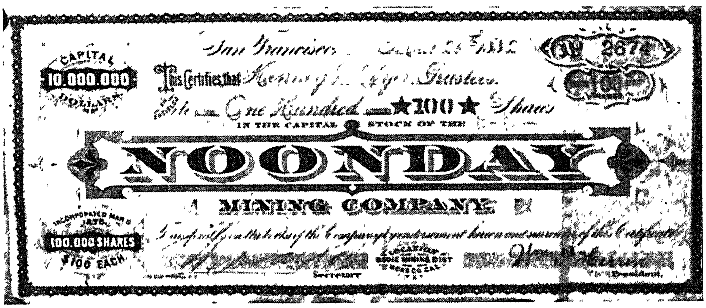


Fig. 127 Copy of Old Mining Shares...by Willard D. Morgan. Focusing Copy Attachment used with Elmar 50mm lens

4. Distance from Lens to Object or (B)
" " Lens to Film Plane (D)

(knowing one how to find the other)

$$\text{Basic Formula: } F = (D-F) \,.\, (B-F)$$

$$B = \frac{D \times F}{D - F} \qquad D = \frac{B \times F}{B - F}$$

Examples:

What is the distance at which the object is to be placed when a 60mm tube and S. F. A. are used with a 135mm lens?

$$B = \frac{(135 + 60 + 11) \times 135}{(135 + 60 + 11) - 135} =$$

$$= \frac{206 \times 135}{206 - 135} = \frac{27810}{71} = 392\text{mm}$$

What Extension tubes are to be used when a 50mm lens is available and the object is 97mm from the lens?

$$D = \frac{97 \times 50}{97 - 50} = \frac{4850}{47} = 103\text{mm} \qquad 103\text{mm} - 50\text{mm lens} = 53\text{mm}$$

or 53mm = 11mm (S. F. A.) + 12mm (tube) + 30mm (tube)

5. Depth of Focus:

The depth of focus for any lens at any opening or distance depends on the diameter of the Circle of Confusion. In all standard Leica formulas the diameter of the Circle of Confusion is taken to be

$$C = 0.03\text{mm}$$

$$\text{Nearest point in focus: } A = \frac{L \times B \times F}{(L \times F) + C\,(B - F)}$$

$$\text{Farthest point in focus: } Z = \frac{L \times B \times F}{(L \times F) - C\,(B - F)}$$

Example:

What is the depth of focus of a 90mm lens at Stop F: 9, focused upon an object 5 meters away, assuming the size of the C. of C. to be 0.01mm?

$$L = \frac{90}{9} = 10\text{mm}; \; B = 5000\text{mm} \qquad C = 0.01$$

$$A = \frac{10 \times 5000 \times 90}{(10 \times 90) + .01\,(5000 - 90)} = \frac{4{,}500{,}000}{900 + 49.10} = 4750\text{mm}$$

$$Z = \frac{10 \times 5000 \times 90}{(10 \times 90) - .01\,(5000 - 90)} = \frac{4{,}500{,}000}{900 - 49.10} = 5300\text{mm}$$

Depth of focus will result in everything being in sharp focus at from 4.75 meters to 5.30 meters.

Avoiding Vibration During Copying

Usually most close-up copy work requires time exposures ranging from ¼ second up to 5 minutes or even more. During such exposures there must be no vibration in the equipment to cause a blurred image on the negative. In order to avoid vibrations the following points should be observed.

1. Use a rigid support for copying equipment.
2. Release shutter with a Wire Cable Release.
3. In case you are working in a building which transmits the annoying vibrations of passing trains, trucks, or a subway, a sponge rubber mat might be placed under the baseboard of the copying attachment in order to absorb the motion.
4. When all the extension tubes are in use have a support or clamp to hold the combination rigid.
5. When vibrations cannot be avoided use more illumination on the object, a larger diaphragm stop, fast film, and make fast exposures.

Focusing

As the camera lens is placed closer to the object the focusing becomes more critical. Naturally without perfect focus the object will be reproduced on the negative as a slight or even complete blur. With the Leica camera there are three methods of obtaining proper focus.

1. By actual focusing upon a ground glass in the Sliding Copy Attachments.
2. By measurement and the use of the printed tables supplied for the purpose.
3. By using the fixed focus attachments such as the Bemar, Belun, Besal, etc.

Ground glass focusing is recommended in the majority of cases because it is so easy to actually see the object projected upon the glass surface which is in the same plane as the film in the camera. A special 5x magnifier is of additional help when determining exact focus with the Sliding Focusing Copy Attachment. In case there is too much stray light falling upon the ground glass, when the magnifier is not in use, take a piece of black paper about 4 x 6 inches in size and wrap this around the ground glass mount. Use a rubber band to hold the paper shade in position around the base. You will now have a paper tube which will keep out any stray light. When the magnifier is in position this paper tube is not required.

The ground glass of the Focusing Copy Attachment looks grainy when examined with the aid of the 5x magnifying glass. Considerable improvement of the clearness of the image is obtained by applying a drop of oil (cocoanut oil is very good) to the ground surface of the glass. Rub the oil in gently and evenly, moving the finger first in one direction, and then at right angles to it. This method will eliminate the graininess considerably and increase the luminosity of the image, permitting better focusing.

Critical Focusing and the Special 30x Magnifying Glass

A special 30x magnifier is available to secure critical focus for those who require the utmost precision and accuracy. This magnifier consists of a small eyepiece equipped with a tiny lens of the microscope ocular type and quality. The lens with its mount slides in a collar which fits into the half-rim clip on the ground glass of the Focusing Copy Attachment. This magnifier cannot be used with the regular ground glass supplied with the

Fuldy Copy Attachment, be it ever so fine-grained. It would only magnify the grain 30 times, but would not resolve the details of the image focused upon the surface.

A special ground glass is available for use with this 30x magnifier. It has a narrow strip of clear glass running across the center of the disc. This clear strip is about 3mm wide. A millimeter scale is engraved in finest hairlines upon the ground side of the glass disc, which corresponds to the film plane in the Leica camera. The scale starts with 0 in the center of the disc and continues to the right and to the left of the 0 in millimeter markings.

The magnifier is placed upon the Copy Attachment just like the regular 5x magnifier. The eyepiece is then moved in or out until the scale engraved upon the glass appears in perfect focus, sharp and clear. Then the object or the camera is moved until the small portion of the object seen through the magnifier appears in sharp focus. It will be found that the image is clear and brilliant and permits the finest hairline adjustment.

This 30x magnifier works upon the principle of picking up the magnified image of the object from the air. The focal point of the lens of this magnifier is so critical, that if the image is not exactly in the film plane, it will appear unsharp until corrected. The focusing should be done with the lens of the camera open enough to permit sufficient illumination to enter for easy focusing. After correct focus has been secured, reduce the lens diaphragm to the desired stop.

Coarse focusing, or the preliminary work in bringing the object into fairly accurate focus upon the ground glass, is secured by placing the camera closer or farther away from the object. In doing this the Sliding Arm to which the camera and Copy Attachment are secured is raised or lowered on the metal upright bar which supports the equipment. In case the camera is in the horizontal position mounted on the Sliding Arm or on a tripod it is only necessary to move either the object or the camera closer or farther away until sharp focus is secured.

When using a 50mm lens, fine focusing can be secured by turning the lens mount or by slowly pushing the lens barrel in or out of the mount. If the 90mm or any other lens besides the 50mm lenses are used the fine focusing is easily secured by slowly turning the focusing mount on each lens until sharp focus is secured.

When working with small objects a convenient stage or mount can be made with an adjustable rack and pinion arrangement similar to the stage of a microscope. Sometimes such a stage can be picked up in a second hand store for only a few dollars; it makes a perfect platform for adjusting small objects. Such a stage is fully described in the chapter by J. M. Leonard on photographing insects.

Focusing by Measurement

When the Leica is to be used without the aid of additional copy attachments accurate focusing may be secured by referring to the special booklet of tables for the Front Lenses, which is available free for any Leica owners who use the Front Lenses in copying. This booklet of tables gives the exact distance between the object and the film of the camera (not the lens), the exact area covered by either one of the three supplementary Front Lenses used, and also the depth of focus at the various diaphragm stops.

When using the Leica with the Front Lenses it is necessary to have the camera secured to the Sliding Arm or to a tripod or any other fixed support, in order to keep the camera perfectly rigid.

Still another method of focusing by measurement is with the use of the various Extension Tubes directly on the camera. When these tubes are used singly or in combination it is not necessary to use the three Front Lenses already mentioned. The Extension Tubes will enable you to use the Leica at closer distances. For those who wish to use the Leica for copying without the use of any copy attachment, a measurement table for use with the Extension Tubes screwed directly into the camera has been prepared by Mr. Lester. The Single Exposure Leica, described in the first chapter, can be used very successfully for testing these fixed distances.

A special copying baseboard can easily be prepared to include the various areas given in the table by marking out the rectangular areas in ink or cut lines in the wood. Each rectangle should have figures giving the area and also the Extension Tube and lens setting required to secure perfect focus. Such a ruled board will be of great convenience for use where many pictures are to be made of objects which are fairly uniform in size.

Stopping Down the Lens

All copying should be done with the lens stopped down to f:6.3 or smaller if possible. As the lens is stopped down the depth of focus increases, thus insuring perfect focus at all times even if a slight miscalculation has been made when securing the original focus. When working with high magnifications the lens should always be stopped down to f:12.5. A special diaphragm Attachment Ring is available for use with the Hektor and Elmar 50mm lenses, in order to adjust the diaphragm with side calibrations and thus avoid the necessity of standing on one's head to read the settings on the face of the lens in case it is pointing down toward an object.

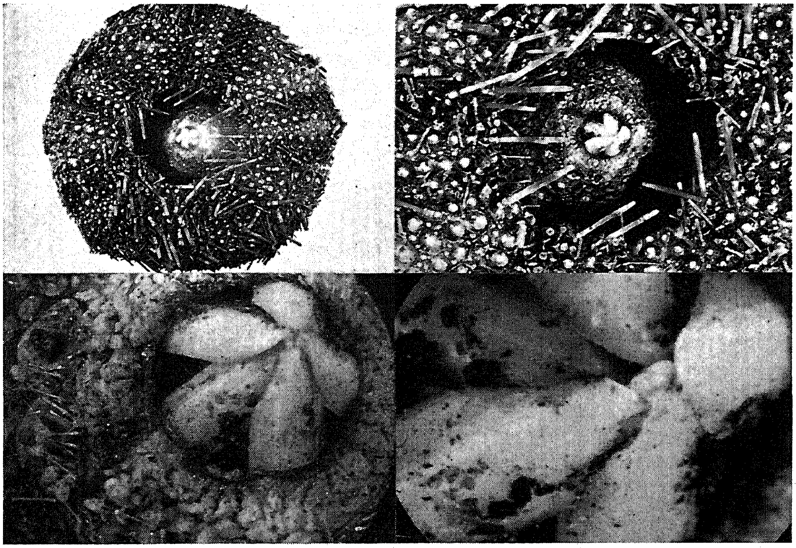


Fig. 128 Sea Urchin (Original Specimen 1½ inches diameter). Series of Four Pictures by Willard D. Morgan

Photographs made with Focusing Copy Attachment and various extension tubes to secure different magnifications. Highest magnification made with a 21 cm tube extension.

Fixed Focusing

The various fixed focus attachments such as the Belun, Behoo, and Bazoo are of value for certain uses and when only a few areas are to be covered. The Belun attachment is permanently in focus for making pictures the exact size of the Leica negative or a 1:1 ratio. The Behoo and Bazoo have extension legs with markings for special settings and areas covered. Complete information about these attachments will be found in a special booklet from the Leitz Company.

Securing Proper Illumination

The importance of proper illumination of objects to be photographed at close range cannot be over-emphasized. Objects can be flooded with strong light until they become flat, lifeless, and washed-out reproductions on the negative. However with the proper type of lighting the very same objects will take on a richness of tone value which makes the final picture strong and at the same time a perfect reproduction of the original.

One of the first methods of checking proper lighting is by personal observation. Side, top, or back lights may be adjusted at various distances from the object, diffusion screens can be used to soften strong direct light rays, high or low power bulbs should be used when necessary. In some cases it may even be necessary to set up one or more flash bulbs for making the picture. In most cases the lights can be adjusted visually.

The best way to check the intensity of the illumination over an object such as a manuscript page, is by using an exposure meter. When in doubt about the proper balancing of the lights this meter provides a rapid means of checking.

For the majority of objects the ordinary side lighting with the lights set at a 45° angle is sufficient. One or two lights are placed on each side, depending upon the size of the object. When these lights are placed at a 45° angle the strong light rays illuminate the area to be photographed without causing back reflections which would ruin the picture, or at least make it fall short of becoming a perfectly illuminated reproduction.

A convenient lighting set-up consists of two ordinary desk lamps with reflectors. Two frosted 75-watt bulbs are sufficient for illuminating all areas up to 12 x 16 inches. Beyond this area use four or more lamps as required. Even such a rule may not hold for every set-up, because it is possible to use two photo-flood lamps or two 500-watt lamps in reflectors and evenly illuminate greater areas. If you have a Kodalite, Solite, or similar lighting outfits they can be used very successfully for copying. Usually the high power bulbs must

be replaced with globes of lower light intensity in order to avoid over-illumination.

It is also possible to use normal daylight when convenient, although artificial lighting is more constant and easier to control. Sometimes when copying in libraries it is not possible to carry in extra equipment such as lights. Here is where it is necessary to use natural daylight. When photographing under such conditions the full illumination from a window is sufficient. Avoid any cross lighting from other windows which may cast shadows or otherwise cause uneven illumination.

Strong lights are useful when photographing moving subjects where short exposures are required. In some cases the strong lights may cause too much heat or otherwise disturb the subjects. To avoid this the focusing may be done with a small light, then when the exposure is to be made the full illumination is snapped on just before the shutter is released. It may also be advisable to use stronger lights when heavy color correction filters are used, thus reducing long exposures.

Lighting Medical Specimens

Macro photography of gross specimens is a term often heard when referring to the copying of medical objects such as bone sections, animal or human organs, or sections of tissues. Here is where a knowledge of lighting is of special importance in order to obtain good detail in the objects and also avoid glistening high lights or bad reflections. In some cases the objects can be placed under water in a large glass specimen jar, with the light directed from the sides. Annoying reflections are thus avoided.

When a medical or any other subject is to be reproduced with a plain white background there are three ways to do this.

1. Make the photographs and then opaque the negative by painting around the object with opaque paint.
2. By using a white surface as a background for the object.
3. Produce a strong back lighting through an opal or ground glass. Such a backlight will overexpose the background around the object. The specimen is illuminated from the top in the usual way. When the paper enlargement is made from this negative the background will reproduce perfectly white if the exposure is made for the object only.

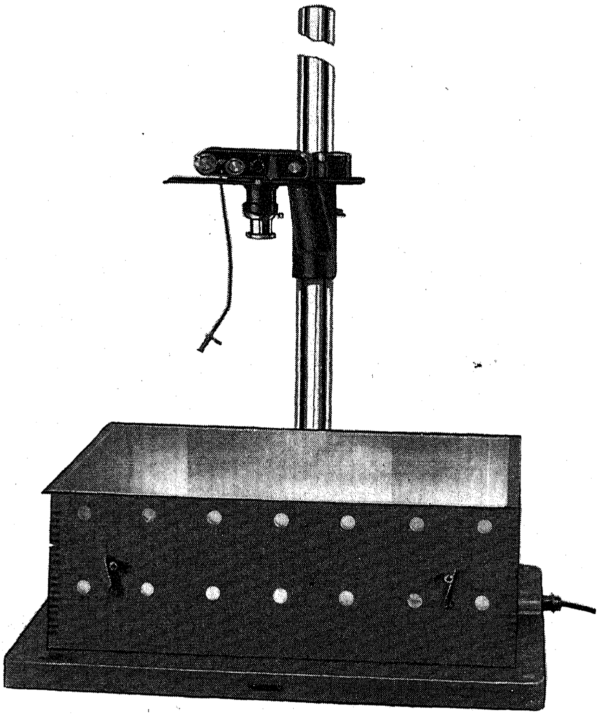
One of the most useful accessories for copy work is an illuminated light box. With such a box the under or back lighting is easily controlled, because the lights may be switched on for only part of

the time while the exposure is being made for the specimen mounted on top of the ground glass. Such a lighting also helps to eliminate unnecessary shadows when necessary. The top lights are used for illuminating the object.

When a jet black background is required for a light object it may be obtained by using a red glass, or celluloid, or paper, in the illuminated box providing positive or orthochromatic film is used in the camera. The red does not register on this film, therefore when the finished enlargement is made a rich black is secured for the background. Black paper or cloth may also be used for a similar purpose.

Still another lighting set-up which produces a white background without shadows can be prepared by mounting a clear pane of glass about six inches or more above a plain white surface which is strongly illuminated. By arranging the top lights at the proper angles the shadows are cast out of photographing range while the illuminated white surface produces an even background. This arrangement is of value for photographing many objects besides medical specimens.

Fig. 129 Focusing Copy Attachment Set-up with Illuminated Light Box for Copying X-rays, and Objects which Require an Illuminated Background



Exposure Time in Copying

As the camera is placed closer to objects and the lens is separated farther from the film plane, the relative exposure time increases. Consequently the values of the diaphragm stops vary according to the degree of reduction or magnification. For example, when photographing objects in actual size on the Leica negative the diaphragm of the 50mm lens will be 100mm from the film plane. In other words, when photographing objects actual size on the Leica negative the distance between the nodal plane of the lens and the film must be twice as great as the focal length of the lens. With such varying conditions the actual value of the stop changes, with the resulting changes in exposures. Once the correct exposure for a given distance has been determined the exact factors for exposures at different settings may easily be determined by referring to the tables.

The following six points must be observed before determining the exact exposure time:

1. Intensity of the light used.
2. Diaphragm stop to be used.
3. Speed of the film.
4. Multiplying factors of any filters used.
5. Character of the object to be copied, which may be dark or light, rough or smooth.
6. The distance between the lens and the film, which determines the exposure factor for reduction or enlargement as given on page 198.

When photographing very small objects it will be found that it is difficult if not impossible to get a reading on the exposure meter, which will be correct. This is due to the fact that the average meter usually covers a much greater field than that occupied by the object. It will be found helpful to get a piece of paper of about 5 x 7 inches or some other material of a brightness or color similar to that of the average color or brightness of the object and get a reading on that by placing it approximately in the plane of the object with relation to the light source. In the case of insects or similar small objects it will be found most expedient to color a piece of paper with water colors, giving it the average tint of the texture of the insect.

The most accurate method of determining exposures when copying is to make actual test pictures with different exposure times. A short length of film may be placed in the Leica magazine and exposed under varying, lighting, filter, diaphragm, and magnification or reduction conditions. Develop this film the proper time and then study the results and determine the exact exposures to be given on the next roll of film which will be exposed under the correct requirements.

Even a single exposure can be made on a short piece of film inserted directly into the Leica after the Film Magazine and Take-Up Spool have been removed. To do this, cut a piece of film approximately four inches in length and insert directly into the camera back of the shutter. Press one end down ahead of the other to avoid catching the film edge on the lower metal frame which determines the margin along one side of the negative. Try loading in daylight first, the exact position of the film will be quickly seen if the focal plane shutter is set at Time and held open. As 35mm film is inexpensive this method of testing exposures will be a real time saver and also help produce perfectly exposed negatives when the good roll of film is used.

The Single Exposure Leica, described in the first chapter, can also be used for making single negative tests. In addition to this camera there is a convenient single exposure film holder for use directly in the regular Leica camera.

Always keep accurate written records of exposures and notes about filters, diaphragm stops, illumination, etc., when copying. After each roll of film is developed, mark the perfect exposures in your record. Then after a number of rolls have been exposed and recorded a final master exposure table should be made for future reference.

Films Used in Copying

When selecting a film for copy work it is very important to have a thorough understanding about the various film emulsions and just what to expect from each one used. You may have attempted to copy a book page or an article from your daily newspaper with one of the fast panchromatic films and then wondered why the finished negative looked flat without much contrast after development. Or you may have copied an original photograph with a slow positive film and wondered why some of the shadows disappeared and became black blotches in the negative or final enlargement.

Films for copy work may be roughly divided into four main classes as follows:

1. Slow positive films.
2. Slow panchromatic films such as Micropan, Panatomic, Finopan, Perpantic.
3. Orthochromatic films.
4. Fast Panchromatic films.

Positive film is contrasty and has an extremely fine grain emulsion. This film obtains its name from the fact that it is used in the motion picture industry for making positive prints from original negatives for projection. Likewise this film is best for making positive prints for projection in the Leica projectors. As positive film is not sensitive to any color except blue and violet, it should not be used when copying colored objects when correction filters are to be used. Use Dupont Micropan for this purpose.

Use positive film for copying . . . printed matter such as books, newspapers, charts, maps, line drawings, and objects which may require extreme contrast in the final negative and enlargement. As positive film is not sensitive to red this color will not register and thus there will be a clear portion on the negative which prints black when enlarged. This film characteristic can be put to excellent use when copying maps with red and black lines, stamps printed in various red shades, or any other subjects where the red lines should appear black in the finished paper reproduction. A filter is not required for this type of work, just use the positive film for making the negatives in the Leica, and make the exposures in the usual way.

Use the slow panchromatic films such as Micropan for copying . . . multi-colored printed matter, blue prints, or whenever correction filters are to be used for obtaining special effects or more contrasty results. For example a snappy black and white reproduction may be required from an old newspaper yellowed with age. How can we obtain the proper results? To do this simply use Micropan film with a number II or III yellow filter. In case still more contrast is required use a Wratten G or even a light red (A) filter.

When copying a miscellaneous collection of subjects which may require some color correction along with others which do not require any Micropan film is recommended as the most practical film for all around use. This film can be used without filters for the ordinary black and white copying.

Use the orthochromatic films for copying . . . original photographs and objects where a better gradation of values must be secured in the final reproduction. The orthochromatic films are fine grained and are not as contrasty as the positive emulsions. In case positive film is not available it is possible to use one of the orthochromatic films for copying printed matter and secure pretty good results, provided a contrast developer is used. The Perutz Fine Grain Film is very good for this type of work while the Agfa Plenachrome, Gevaert Superchcrome, and others can also be used.

Use the fast panchromatic films for copying . . . paintings, moving objects which require fast films, and any subjects which require color correction filters and short exposures at the same time. This film gives more latitude, or in other words there is more gradation of values between the highlights and shadows, this is of special value when copying paintings which require faithful reproduction of the delicate color gradations.

Developing Films in Copy Work

Copy films are developed according to the results required just as the proper film is selected for obtaining definite results. The usual technique which is fully explained in the chapter on developing applies equally well to the processing of copy films. The only important variation comes when developing the positive or the Micropan films where greater contrast is required and development can be prolonged if necessary.

After printed matter or similar subjects have been copied on positive film one of the developers to use in finishing the negative is the Eastman D-11 solution which is mixed as follows:

Contrast Developer (D-11)

Water (about 125° F.)	**16**	**ounces**	**500**	**cc**
Elon (Metol, Pictol, etc.)	**15**	**grains**	**1**	**gram**
Sodium Sulphite	**2½**	**ounces**	**75**	**grams**
Hydroquinone	**130**	**grains**	**9**	**grams**
Potassium Carbonate or Sodium Carbonate	**360**	**grains**	**25**	**grams**
Potassium Bromide	**70**	**grains**	**5**	**grams**
Cold water to make	**32**	**ounces**	**1**	**liter**

This formula used at 65° will give very good contrast in five minutes. When less contrast is desired, the developer should be diluted with an equal volume of water.

Development of the positive film should be carried out for the full time. If the negative becomes too dense during this developing time it means that too much exposure has been given when copying the original subject. Only the finest negatives result from perfect exposures and complete development. Of course one can watch the development of positive

film under a red safelight and slightly underdevelop the film if it is seen that the exposures were too heavy. However the finished enlargements from such negatives will not have the snappy quality which can be secured by full development of a perfectly exposed negative.

In case extremely contrasty results are required on positive film a caustic developer such as the Eastman D-9 will produce the correct results.

Caustic Process Developer (D-9)

Stock Solution A

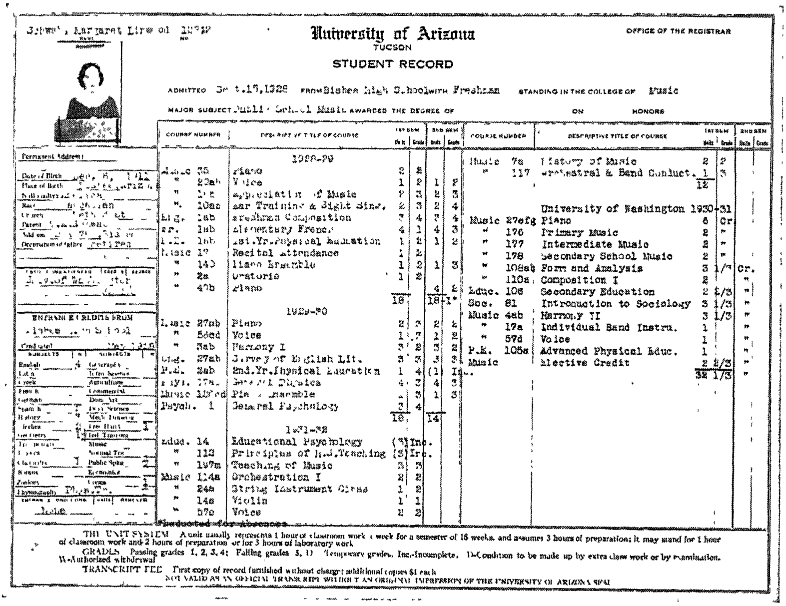
Water (about 125° F.)	**16**	**ounces**	**500**	**cc**
Sodium Bisulphite	**¾**	**ounce**	**22½**	**grams**
Hydroquinone	**¾**	**ounce**	**22½**	**grams**
Potassium Bromide	**¾**	**ounce**	**22½**	**grams**
Cold water to make	**32**	**ounces**	**1**	**liter**

Stock Solution B

Cold water	**32**	**ounces**	**1**	**liter**
Sodium Hydroxide (Caustic Soda)	**1¾**	**ounces**	**52½**	**grams**

Use equal parts of A and B and develop about three minutes at 65° F. Cold water should always be used when dissolving Caustic Soda because considerable heat is evolved. Solution A should be stirred thoroughly when the caustic alkali is added, otherwise the heavy caustic solution will sink to the bottom.

This developer oxidizes quite rapidly and cannot be used over again after the first developing. Therefore it is best to make several short test



University of Arizona
TUCSON
STUDENT RECORD
OFFICE OF THE REGISTRAR

ADMITTED [illegible] FROM Bisbee High School WITH Freshman STANDING IN THE COLLEGE OF Music
MAJOR SUBJECT Public School Music AWARDED THE DEGREE OF ON HONORS

COURSE NUMBER		DESCRIPTIVE TITLE OF COURSE	1st Sem Units	1st Sem Grade	2nd Sem Units	2nd Sem Grade
		1928-29				
Music	35	Piano	2	2		
"	23ab	Voice	1	2	1	2
"	[illegible]	Appreciation of Music	2	3	2	3
"	10ab	Ear Training & Sight Sing.	2	3	2	4
Eng.	1ab	Freshman Composition	3	4	3	4
Fr.	1ab	Elementary French	4	1	4	3
P.E.	1ab	1st.Yr.Physical Education	1	2	1	2
Music	17	Recital Attendance	1	2		
"	143	Piano Ensemble	1	2	1	3
"	2a	Oratorio	1	2		
"	47b	Piano			4	2
			18		18+1*	
		1929-30				
Music	27ab	Piano	2	3	2	2
"	56cd	Voice	1	2	1	2
"	3ab	Harmony I	3	2	3	2
Eng.	27ab	Survey of English Lit.	3	3	3	3
P.E.	2ab	2nd.Yr.Physical Education	1	4	(1)	Inc.
Phys.	[illegible]	General Physics	4	2	4	3
Music	123cd	Piano Ensemble	1	3	1	3
Psych.	1	General Psychology	3	4		
			18		14	
		1931-32				
Educ.	14	Educational Psychology	(3)	Inc.		
"	113	Principles of H.S.Teaching	(3)	Inc.		
"	197m	Teaching of Music	3	3		
Music	124a	Orchestration I	2	2		
"	24a	String Instrument Class	1	2		
"	14a	Violin	1	1		
"	57c	Voice	2	2		

COURSE NUMBER		DESCRIPTIVE TITLE OF COURSE	1st Sem Units	1st Sem Grade	2nd Sem Units	2nd Sem Grade
Music	7a	History of Music	2	2		
"	117	Orchestral & Band Conduct.	1	3		
			12			
		University of Washington 1930-31				
Music	27efg	Piano	6	Cr		
"	176	Primary Music	2	"		
"	177	Intermediate Music	2	"		
"	178	Secondary School Music	2	"		
"	108ab	Form and Analysis	3 1/3		Cr.	
"	110a	Composition I	2		"	
Educ.	106	Secondary Education	2 2/3		"	
Soc.	81	Introduction to Sociology	3 1/3		"	
Music	4ab	Harmony II	3 1/3		"	
"	17a	Individual Band Instru.	1		"	
"	57d	Voice	1		"	
P.E.	105a	Advanced Physical Educ.	1		"	
Music		Elective Credit	2 2/3		"	
			32 1/3		"	

Permanent Address
Date of Birth
Place of Birth
Nationality
Race
Church
Parent
Address
Occupation of father Retired
ENTRANCE CREDITS FROM
Graduated
*Inducted for absences

THE UNIT SYSTEM A unit usually represents 1 hour of classroom work a week for a semester of 18 weeks, and assumes 3 hours of preparation; it may stand for 1 hour of classroom work and 2 hours of preparation or for 3 hours of laboratory work
GRADES Passing grades 1, 2, 3, 4; Failing grades 5, 0 Temporary grades, Inc.-Incomplete, D-Condition to be made up by extra class work or by examination. W-Authorized withdrawal
TRANSCRIPT FEE First copy of record furnished without charge; additional copies $1 each
NOT VALID AS AN OFFICIAL TRANSCRIPT WITHOUT AN ORIGINAL IMPRESSION OF THE UNIVERSITY OF ARIZONA SEAL

Fig. 130 Copy of Student Record C. Zaner Lesher
An Example to Show How the Copy Equipment can be Used for Saving Considerable Time in Copying all Types of Records.

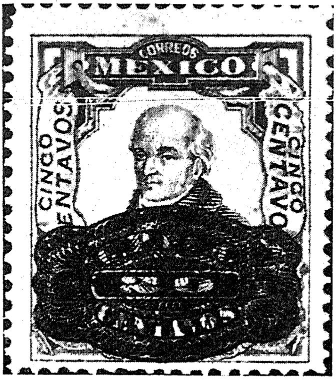


Fig. 131 Orange Stamp with Black Surcharge...Green Filter used to Give Better Black and White Contrast.

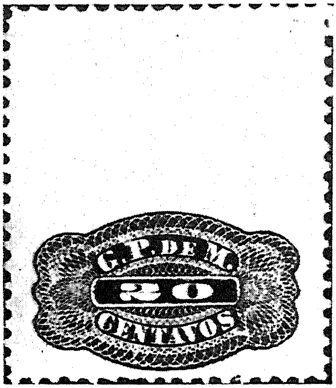


Fig. 132 Same Stamp as Fig. 131. Red (F) Filter Used to Absorb Orange Color of Original Stamp, Permitting only Black Surcharge to Register.

Fig. 133 Genuine Stamp. Note the Clear Design of this Stamp as Compared to the Forgery Shown in Fig. 136.

Fig. 134 Detail of Genuine Stamp. Note Clear Detail and Individual Parts which Differ From Forged Stamp Shown in Fig. 135. The Second Ray to the Left of the Sprout Almost Touches the Ground.

Fig. 135 Detail of Forged Stamp. Note that the printing is not as Clear as the Genuine. The Second Ray to the Left of the Sprout Coming Out of the Ground is Farther Away from the Ground.

Fig. 136 Forged Stamp. A recent attempt to copy original Latvia Stamp.

Photographs made by Willard D. Morgan...using Focusing Copy Attachment with 3 cm Extension Tube for full size stamps and 9 cm tube for magnifications.

strips or even single negatives of the copy material and develop in a small tray in order to determine the exact exposures before putting through the full Leica film roll. Two rolls of positive film can be wound into the Correx developing tank back to back and developed at one time if necessary, if the operator has sufficient skill in handling film in this manner.

Filters Used in Copying

For most copy work only two or three filters will be required. Even then a considerable amount of copying may be done without filters. The chapter on filters will give complete information; however a few examples where filters may be used with panchromatic films in copying may be tabulated as follows:

1. Wratten G filter . . . used for copying printed matter on yellowed paper in order to produce a clear black and white reproduction.
2. Yellow number II or III filters . . . when copying paintings to secure proper balance of color values in the black and white reproduction. Colored maps may require one of these filters to bring out the proper legibility. For example the names of cities may be printed in black over a light red or orange background. With ordinary positive film the color would turn dark and the contrast would not be sufficient. However, by using the yellow filter the background is kept lighter so that the names are readable, and yet there is a suggestion of the shaded area. In case the red background is to be eliminated entirely use one of the red filters.
3. Wratten A (red) or similar filters . . . excellent for use when copying blue prints to make the blue background reproduce black on the final enlargement. Blue or violet typewriting reproduces black when the red filter is used. This filter may be used in many ways for securing special results. For example the red design of a postage stamp will disappear entirely when this filter is used, thus leaving a black surcharge in bold relief for special study.

The tri-color set of filters, Wratten A (red), B (green), and C5 (blue), is very useful for securing over corrected negatives when certain results are to be obtained. When the colored object is viewed through a filter it is possible to obtain some idea about the final result. The eye looks upon objects and determines the differences either by the contrast in colors or contrast in dark and light. Naturally the reproduction of dark and light on the photographic film creates new difficulties, and it is sometimes better to over correct one color to get the proper contrast.

A simple rule to follow when using the tri-color filters is to use the filter which absorbs the color which is to be reproduced as black. Thus if the green (B) filter is used for copying a map printed in red lines or red typewriting, the result will be black lines or typewritten letters on the white paper. In case a red filter was used the red typewriting would be entirely eliminated and only a white blank

sheet of paper reproduced. There will be colored objects which require certain compromises when using filters to show contrast or gradation and detail as required.

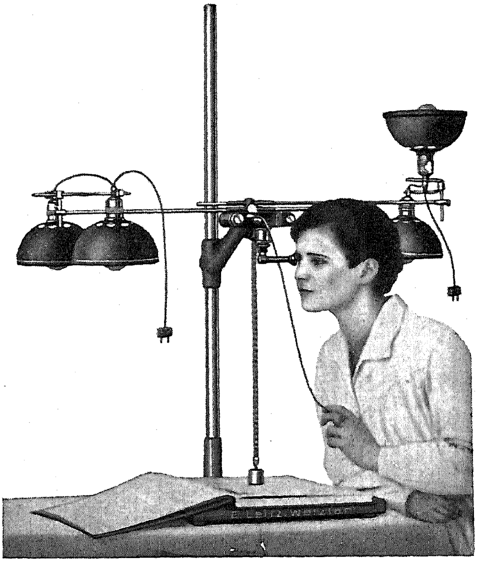
The longer the focal length of the objective the more accurate the filter must be for copying. This is why the 50mm lens is excellent because of its short focal length.

Collapsible Reproduction Stand

While traveling or when working in libraries or similar places the complete equipment must be kept as light and portable as possible. For this use, the Collapsible Reproduction Stand is available. This apparatus consists of a number of tubes fitting into one another, two supporting base bars, and the extension arm for attaching the Leica or the Sliding Copy Attachment. As the upright is about 22 inches high the No. 2 and No. 3 supplementary front lenses can be used. The vertical and horizontal tubes have graduated scales in fractions of an inch.

When the Leica is used with the Front Lenses a plumb weight is used for determining the exact center of the object to be copied. Then by referring to the lens table booklet, which is supplied with the lenses, the exact focus and distance settings can be quickly made. A special light bracket containing two lights is also available for attaching to the extension arm of this outfit.

Fig. 137 Reproduction Stand Equipped with Sliding Arm, Illuminator, Leica with Wintu Angle View Finder, Measuring Tape, and Wire Cable Release. The Collapsible Stand is Smaller but a Similar Set-up can be made.



Auxiliary Reproduction Devices

For certain types of close-up photography the Auxiliary Reproduction Attachments are of value. These attachments provide a fixed focusing arrangement which can be applied for special areas from 1 x 1½ inches up to 8½ x 12½ inches. **The Belun Device** is used with the Leica equipped with the Elmar 50mm lens for obtaining 1:1 or natural size copies. This same equipment is also available for the Hektor and Summar 50mm lenses, and the Elmar 35mm lens. This equal-size reproduction device may be used for copying portions of maps, coins, postage stamps, finger prints, handwriting specimens, small insects, plants, seeds, and any other object which can be included in the 1 x 1½ inch area. The accompanying illustration will show how this attachment is set up.

The Behoo Device is used for obtaining reduction ratios of 1:1½, 1:2 and 1:3 with the Leica. The greatest sizes of the objects at the three different ratios are, 36 x 54mm, 48 x 72mm, and 72 x 108mm. As a complete direction booklet is available for this attachment as well as the other Auxiliary D Copy Devices it will not be necessary to make a reprint. The Behoo Device uses three Extension Tubes for securing the three different fixed focusing positions. When the No. 2 and No. 3 Front Lenses are used there is an attachment known as the **Beooy** which covers areas from 3½ x 5 inches up to 8½ x 12½ inches. Still another similar attachment is known as the **Bazoo** which is a combination of the Behoo and the Beooy Devices. The accompanying illustrations will give a good idea about the way in which these copy attachments are set up.

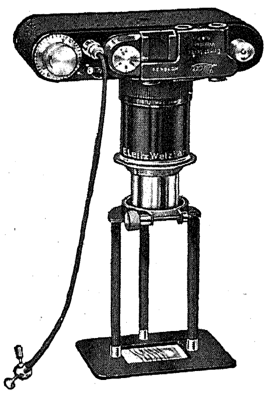


Fig. 138 The Belun 1:1 Copy Device used for Making Actual size Copies 1 x 1½ inches.

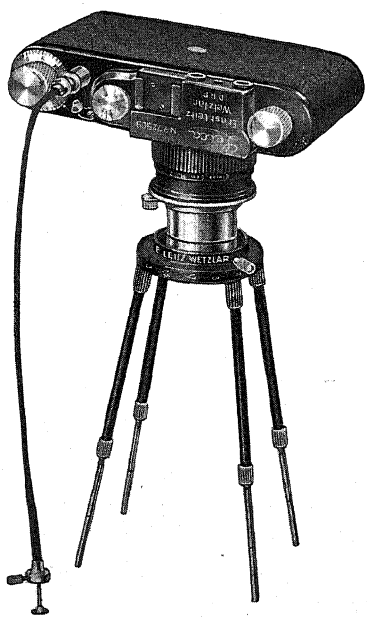


Fig. 139 Auxiliary Reproduction Device for use with Extension Tubes and Front Lenses directly on camera.

Special Rotating Copy Attachment

Still another type of copy attachment which has recently been made available is the Rotating Copy Attachment which serves the same purpose as the Sliding Focusing Copy Attachment already described. The Rotating Device, as shown in the illustrations, can be used for copying all areas similar to the Sliding Attachment. The booklet accompanying this Rotating Copy Device gives complete tables and directions for operation.

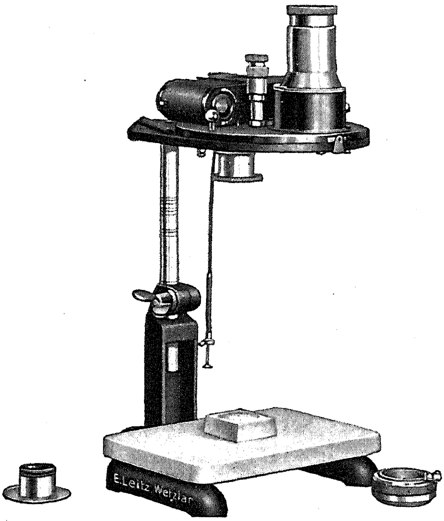


Fig. 140 Rotating Stage Copy Device. Note 5x Magnifier on Device and 30x Magnifier at Lower Left.

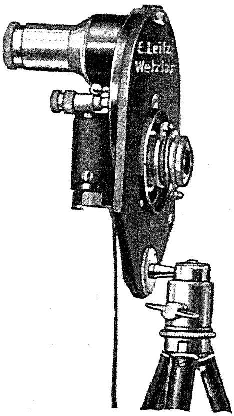


Fig. 141 Rotating Stage Copy Device as used in vertical position.

A very convenient attachment for the Rotating Copy Attachment is known as the Rotating Stage Plate which can be used for photographing small objects such as minerals, medical specimens, art objects, photographs, or handwriting. This attachment (Fig. 140) has a magnification range from 1:1 to 1:4 and focusing may be secured by direct visual inspection of the ground glass or by using the calibrated upright. It will be noted that there are three engraved lines at the four different focusing positions on the upright. The top line in each case is for use with the Summar 50mm lens, the second line for the Elmar 50mm lens, and the bottom line for the Hektor 50mm lens. At the 1:1 position the picture area is the same size as the Leica negative or approximately 1 x 1½ inches while at the 1:4 point the maximum area covered is 3 4/5 x 5 3/5 inches. When using

the calibrate scale of the Rotating Stage Plate it is necessary to use the intermediate rings recommended for this arrangement. Here again it is possible to obtain from the Leitz Company a complete direction booklet and also a special chart giving the exact areas covered with full information about intermediate tubes and the distances.

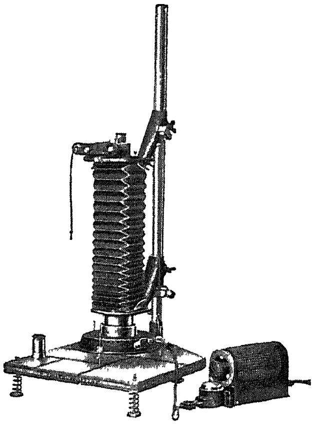


Fig. 142 Special Copy Device with bellows extension. Note Ring Illuminating Device used for Securing Proper Illumination of Specimens.

When using the Special Rotating Copy Attachment it is possible to photograph objects 17 x 26 inches in size or minute objects only 1/10 x 3/20 inches in size. When a microscope is added as shown in Figure 143 one can obtain magnifications up to several thousand diameters. A brief summary of the basic equipment for the Special Rotating Attachment as shown in Figures 142 and 143 is listed as follows:

1. A 19 x 27 inch baseboard mounted on shock absorbing springs which can be clamped rigidly or left in free suspension.
2. An upper and lower copying arm which can be moved as required for focusing.
3. The upper arm is fitted with a clamping screw for holding the Rotating Copy Attachment while the lower arm holds the lens mount and the extension bellows.
4. A fine focusing ring is provided at the base of the lower arm.
5. The upright pillar is 4 feet high, and 1¼ inches thick.
6. A ring illuminator with rheostat provides the maximum of lighting efficiency.
7. The 5X and 30X magnifiers are used with this equipment in the same way as required for the Sliding Copy Attachment.

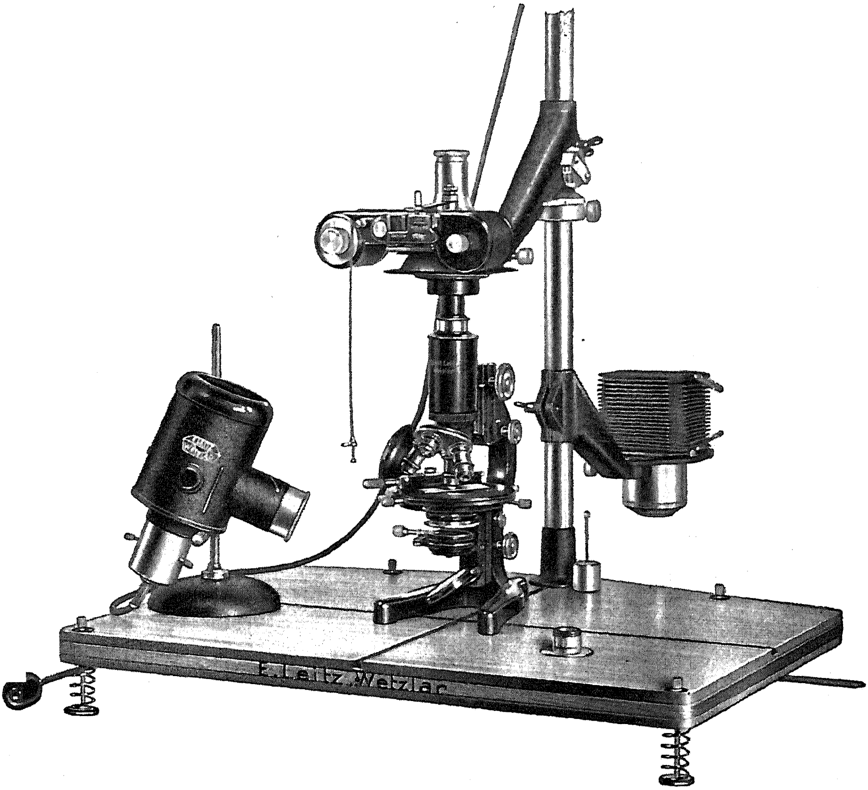


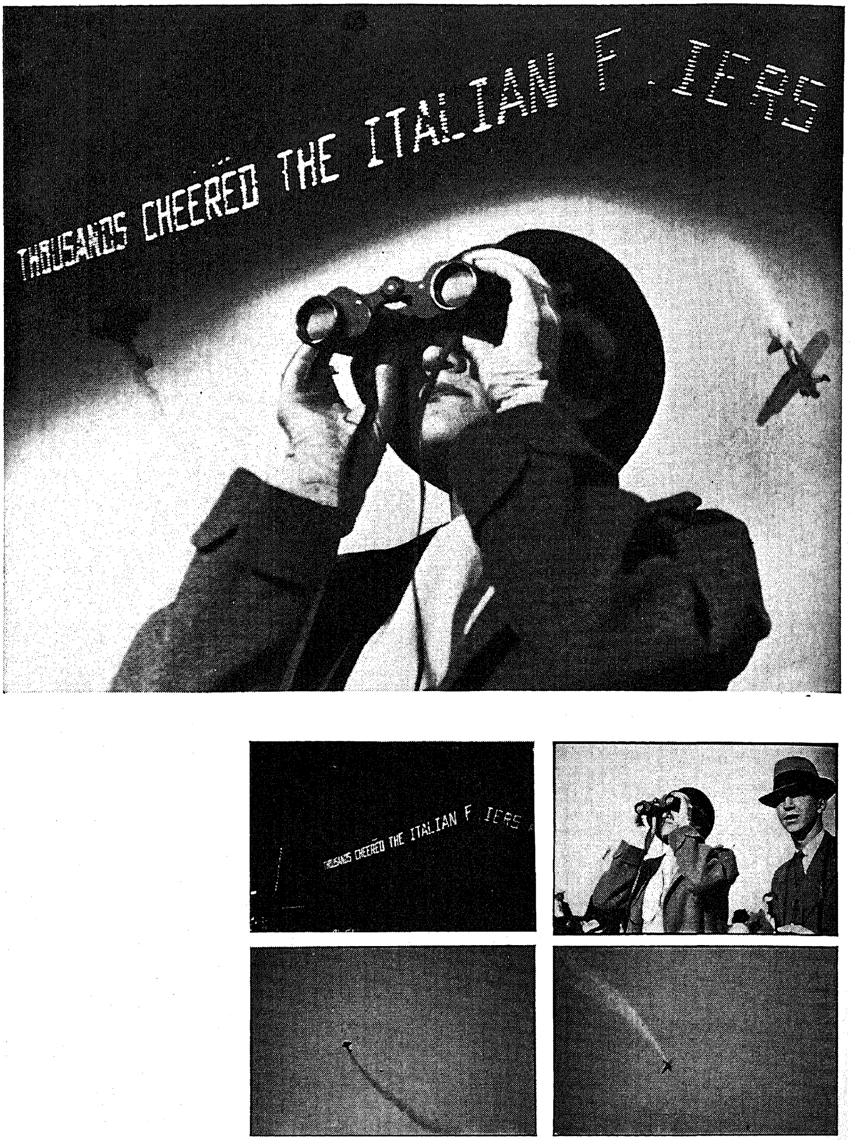
Fig. 143 Sliding Copy Device equipped for use with the Model FF 250-exposure Leica. Illustration shows camera in position for use with the microscope.

250 Exposure Leica Model FF

When many photographs are to be made of book pages or other subjects the 250 exposure Leica is valuable as a time saver. This camera can be used on the regular Sliding Arm, on a tilting top tripod, or in connection with a special Sliding Copy Attachment. This camera can also be used conveniently with the microscope for making many photographs in rapid succession of still or moving objects.

Conclusion

As the subject of copying is such a broad one an entire book could easily be written in order to include the many interesting methods and applications. However this chapter will give the essentials from which the Leica user can select the information required for his own work.



The Fliers
A Four-Negative Photo-Montage

John T. Moss, Jr.

MAKING LEICA POSITIVES FOR PROJECTION

WILLARD D. MORGAN

CHAPTER 10

Undoubtedly the best way in which to view Leica pictures is by projection upon a screen. In this way the projected image not only has a large area, but it also yields more of a plastic quality which closely resembles the original subject. Such pictures may be projected in full natural colors, in various tones, as well as the ordinary black and white film or glass slides. In these projected pictures, a large group of people may be able to enjoy the same picture at the same time. As most Leica pictures are made with shorter focal length lenses, the negatives produce positives which give an almost stereoscopic effect. This is due to the excellent depth of focus in the Leica lens. In contrast to the projected positive, the small 5 x 7 or 8 x 10 inch paper prints do not create the luminosity and brilliance which are to be found in the projected picture.

One reason why a greater use and appreciation of the projected image is not found is possibly because such pictures do not convey the full interpretation of the original negative. This may be due to the following:

1. The positive film or glass slide may lack contrast and brilliance.
2. The picture may not be composed properly on the slide or the original negative may not have a pleasing composition.
3. The positive may be overexposed and thus be too dark on the projected screen, or it may possibly be underprinted with the resulting loss of detail and depth.
4. The projected picture may have pin holes, dust spots, finger prints or other blemishes.
5. The center of interest may be lost in a maze of useless detail.
6. Possibly the positive may lack sharpness due to improper focusing or uneven pressure in the case of contact printing.

In many cases, an interesting Leica negative might be made into a slide for projection instead of viewing the same picture on an 8 x 10 inch enlargement. The projected picture presents a larger and more dramatic effect. At the same time, the film or glass positive emulsion has a greater latitude in the shadows and highlights of the image itself, as compared to the paper enlargement. This is due to the fact that there is a light illuminating the entire picture. In the projected image, even the blackest shadows have illuminated details, providing the positives have been prop-

erly made, while in the paper print there cannot be such transmitted luminosity.

What Makes Good Positives

Leica negatives can be prepared from many different subjects which later may be made up into film and glass slide sets. For example, these sets of positives may include pictures selected from your vacation, travels, photographs of children and pets, or, you may have sets illustrating your particular hobby by photographing the American scene, geological formations, architectural subjects, cartoons, wild flowers, trees, insects and many other subjects which lend themselves readily to photographic interpretation. After illustrating such subjects, it is possible to use these pictures for lecture and visual education purposes, or for your own personal entertainment. In the case of film slides, these pictures may be printed in groups of twenty to forty on one strip of film. On the other hand, the 2 x 2 inch glass slides may be made individually and added to the sets at any time. There is something to be said for each method. The film slides are made more inexpensively while the glass slides are more permanent and may be re-arranged during projection. In addition to using the film and glass slides for general purposes, they are valuable in the commercial field for use in demonstrating sales methods, new products, as well as in training workers and salesmen.

The new Leica Dufaycolor film is excellent for commercial, educational, and for general subjects as well. This colorfilm produces a very satisfactory result when projected.

One of the most important advantages of making Leica pictures for projection is that these pictures require small storage space. For example, twenty-five rolls of positive film slides may easily be carried in a small container. These film rolls may include over 1,000 pictures. With positive film costing only two or three cents per foot, the film of 1,000 pictures would entail a cost of about $3.00, while 1,000 8 x 10 inch enlargements will probably come to over $60.00. A remarkable difference! Even the 2 x 2 inch glass slides are quite small and light in weight when compared to the standard 3¼ x 4 inch glass slides which are commonly used in the large projectors.

A thorough understanding of this chapter on the making of Leica positives, along with the contents of the chapter on Visual Education is essential. The two are closely related. In the same way, all the other chapters in this book are likewise allied, directly or indirectly, to the making of film positives. The making of the original Leica negative is just as important as the fine technique in

the making of the final film or glass slide positive for projection. In other words, a poor Leica negative will not produce a superb Leica positive. On the other hand, an excellent Leica negative can very easily be made into a very poor positive unless proper steps in its preparation are carefully observed.

The Two Positive Printing Processes

There are two ways in which to make the Leica positive film or glass slide. The most common method is by actual contact printing which is accomplished by placing the Leica negative directly in contact with the unexposed positive film or glass plate. The other method is by placing the negative into one of the Leica enlargers and then printing directly by projection. Here again, there are advantages in both methods, the former possibly being completed a little more rapidly and at the same time requiring only a minimum amount of equipment, while in the case of projection, it is easier to omit portions of the image in case a negative must be balanced correctly in printing. The projection method helps in eliminating dust particles and also the best portions of the negatives may be utilized. Both of these methods will be described in detail later in the chapter.

Contact Positive Printers

The Eldia Film Printer represents one of the simplest arrangements for the contact printing of Leica negatives either upon paper or positive 35mm film strips. This printer will hold approximately eight feet of positive film. The raw stock is wound upon one spool and unwound upon another take-up spool after each contact print has been made. A ratchet clicks for each space of three-quarters of an inch which represents the single frame picture area. Two clicks of the ratchet represent the length of the Leica picture. The Eldia Printer is supplied with the standard frame size for the Leica negative. However, in case single frame negatives are to be printed, it is possible to secure a single frame window which is interchangeable on the Eldia Printer. The accompanying illustrations will give a more definite idea about the appearance of the printer.

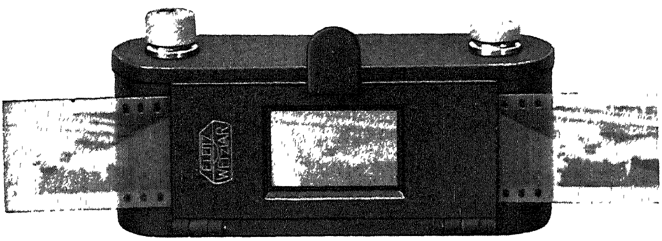


Fig. 146 Eldia Printer. For Making Contact Prints on Positive Film or Paper

When using the Eldia Printer, it is possible to print each negative in its original sequence, or if necessary, important negatives only may be selected and printed upon the positive film stock, which is later developed and used in one of the projectors. In doing this, the negative is pulled past the window of the printer until the proper negative appears. The lid is then clamped into position and the exposure made. Do not wind the film when the top lid is closed or the film will become scratched.

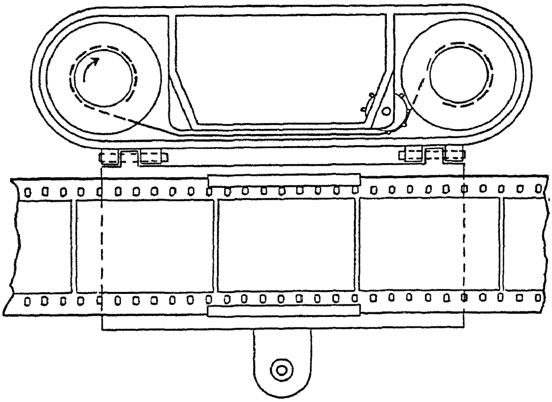


Fig. 147 Positive Film or Paper Passes over Ratchet Wheel and **under** Take-up Spool at Right. Negative Film Passes Through Channel of Hinged Cover.

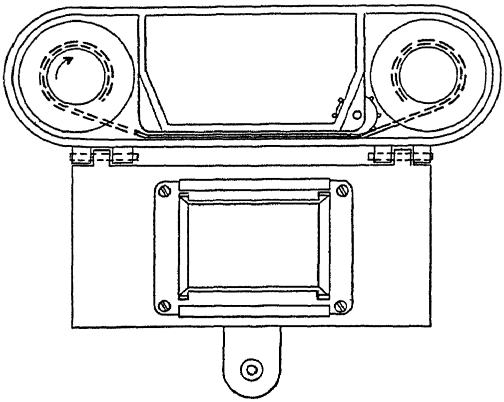


Fig. 148 Alternate Method: Paper and Negative are Both Passed **over** the Ratchet and **over** the Take-Up Spool at the Right.

Directions for Operating the Eldia Printer

Use standard safety base or non-inflammable positive film stock. This may be purchased in various lengths from any photographic dealer.

1. When preparing to load the Eldia Printer, cut off about five or six feet of positive film and wind this upon the spool in the Eldia Printer opposite to the winding spool which has a slightly longer knob for turning.

2. The winding or take-up spool is placed in the chamber next to the small ratchet wheel which marks the successive advance of the Leica frames during printing. After the unexposed film has been wound upon the supply spool, the free end is pointed and attached to the take-up spool. Naturally, the film has been wound with the emulsion side out. The two spools are now placed in their respective chambers in the Eldia Printer, as shown in the accompanying line drawing.

3. Insert the Leica negative into the grooves which are to be found on each side of the glass plate in the cover of this printer, the emulsion side of the negative facing out. In other words, the emulsion side of the unexposed positive and the emulsion side of the Leica negative must come face to face in actual contact when the cover of the printer is closed.

4. After the printer has been closed, it is possible to judge the density of the negative by holding the printer over a small light box, or in case such a box is not available, hold the printer up in front of a low power light bulb for a few seconds in order to estimate the density of the negative through the red plate which is to be found at the base of the printer.

5. One of the easiest methods of exposing each successive negative when using this printer is by placing the apparatus under the Leica enlarger. In case the light in the Leica enlarger is too strong, one or two pieces of tissue paper may be placed in the position which would ordinarily be occupied by a negative for enlarging. This method provides better diffusion of the light. The projection lens in the enlarger should be thrown out of focus.

6. After one exposure has been made, unhook the cover of the Eldia Printer and pull the Leica negative to the next picture. At the same time, turn the positive film until two clicks are heard in the case of Leica films.

7. Make the exposure, after the density of the negative has been determined by flashing on the small light under the printer. Proceed with this method until all the pictures have been printed.

8. **Make certain that the vertical and horizontal negatives are printed in the same way.** In other words, do not reverse the negatives so that the vertical or horizontal pictures show on the screen in different directions when projecting. Also, remember that if the first picture is to start at the beginning of the positive film, the print should be made in such a way as to show it at the beginning of the roll and not reversed, which may be the case if care is not utilized. Simply remember that the positive picture is placed into the projector upside-down with the emulsion side facing the projection lamp.

9. Before printing the full roll of Leica positives, it is best to make a few test exposures of various negatives with varying densities. To do this, cut up short two inch lengths of positive film and place directly into the printer so that the emulsion side will come into contact with the emulsion side of the negative when the cover of the printer is slipped shut. Develop each test film in exactly the same way the full length of positive film is to be developed. Three or four single exposure strips may be easily developed in a small tray for the full time required for the developer. After the test films have been cleared in the hypo, rinse for half a minute in water and then examine them by actual projection in the enlarger or, better yet, use one of the Leica projectors. The wet emulsion

will very quickly melt if exposed too long to the heat of the projector. Until you become an expert in judging the test exposures, it is always best to examine these test films by projection.

10. Make certain that the glass plate in the Eldia Printer is thoroughly cleaned and also keep the negative and positive film free from dust particles which may show on the finished positive film. Do not make more than 36 pictures on one length of film, if it is to be developed in a Reelo or Correx Tank.

11. After the completed strip of positive film has been exposed, development is carried out in the Correx or Reelo Tanks in a manner similar to that in which the Leica negative was developed. The only exception in the process is that the film is developed in a special developer which ordinarily takes about five minutes for complete development.

12. The Glass Developing Drum can also be used for developing the positive films. This drum is quite essential for developing the Leica Dufaycolor film also.

All positive films made for projection purposes should be thoroughly hardened after development. One of the simplest hardeners is Chrome Alum described in the Developing Chapter. After the film has been hardened, cleared in the acid fixing solution, washed, and then dried, it should be rolled up with the emulsion side out if it is to be used in the Umino or Umena projectors. If one of the Udimo projectors are to be used the film may be wound with the emulsion side in.

Making the Leica Glass Positive

Glass 2 x 2 inch positives may be made in the Eldur Glass Slide Printer very quickly by contact printing, as follows:

1. The method of inserting the Leica negative is shown in the accompanying illustration. The 2 x 2 inch glass plate is placed with the emulsion side down directly over the Leica negative. The top hinged pressure plate is then clamped down to hold the glass plate in contact during exposure.

2. The Eldur Printer is then placed under the enlarger and the exposure made by turning on the enlarger light for the correct exposure time, which may vary from 2 to 10 seconds, depending on the negative and the stop used in the enlarger lens. Always use the same illumination when making positives in order to help in making the exposure estimate more uniform. A test slide should be made first by turning on the enlarger light and then make four exposures of 2, 4, 6, and 8 seconds each on the same plate, by moving a card across at each step. When developed, the test slide may be projected and the best exposure quickly determined for the next slide. Sometimes it is more convenient and also less expensive to use a Bromide paper which has the same speed as the plate for testing.

3. The glass slides are developed in the usual slide developer which is given in the same package in which the 2 x 2 inch glass slides come.

The Gevaert Company supplies the 2 x 2 inch glass slides in a medium as well as contrast grade. Barnet slides may also be secured in the 2 x 2 inch size. When making glass slides, it is best to have both contrasts available, in order to obtain the best results from negatives which may be contrasty or flat. Usually, the contrast grade will be used. After exposing, developing and fixing the glass slide, it should be tested in the projector

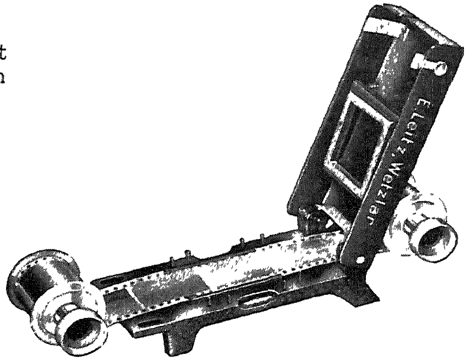


Fig. 149 Special Eldur Contact Printer for Making 2 x 2 inch (50mm x 50mm) Glass Slides

for correct exposure and development. While still wet, it may safely be projected two or three seconds. After making thousands of glass slides, I still recommend that each slide be placed in the projector and flashed upon the screen for an instant since this is the only way in which the finest glass slides can be produced. If the light of the projector is flashed for only two or three seconds through the wet slide, there will be no effect upon the positive. However, if the wet plate is allowed to remain in the projector for a half minute or more, the emulsion will warm up and melt, thus ruining the slide. It is very easy to have the projector in the dark-room for this purpose. A small image projected upon a white cardboard is sufficient for determining the quality of the slide.

A good developer for use with the 2 x 2 inch glass slides is prepared as follows:

Gevaert Contrast Developer for Slides

Metol	**11 grains**	**0.75 grams**
Hydroquinone	**45 "**	**3.0 "**
Sod. Sulphite (des.)	**175 "**	**25.0 "**
Sod. Carbonate (monohydrate)	**350 "**	**53.0 "**
Pot. Bromide	**8 "**	**0.5 "**
Water to make	**16 oz.**	**500.0 cc**

The chemicals must be dissolved in the order named. A very good plan is to dissolve every product in water, mixing in the order named. The bath is then filled up with water to the mentioned quantity.

At a temperature of 65° F., lantern plates develop in from 1½ to 2½ minutes.

Make certain that the exposure is such that the positive plate will remain in the developer for at least two and a half to three minutes without becoming overdeveloped. In case the image flashes up too soon and the plate is removed at the same time from the developer, the resulting positive will not have the rich transparency and brilliance which occurs when the plate is properly exposed and fully developed. **This is where many workers make a mistake.** Never underdevelop

a positive but on the contrary, carry the development to the recommended length of time. Even a minute over this time will be better than a minute under. The Universal Developer described in the chapter on Enlarging Papers may also be used for positive films or glass slides.

Whenever more contrasting results are required on positive glass plates, it is necessary to use a contrast developer. The Eastman D-11 Developer produces good contrast, while the Eastman D-9 Caustic Developer produces extreme contrast. The D-9 Developer is particularly well suited for line work, where extreme contrast is desired.

Hydroquinone-Caustic D-9 Developer

For Process and Panchromatic Process Films and Glass Slides
For Tray Development

	Avoirdupois	Metric
Stock Solution A		
Water (about 120° F.) (52° C.)	16 ounces	500.0 cc.
Sodium Bisulphite	¾ ounce	22.5 grams
Hydroquinone	¾ ounce	22.5 grams
Potassium Bromide	¾ ounce	22.5 grams
Cold water to make	32 ounces	1.0 liter
Stock Solution B		
Cold water	32 ounces	1.0 liter
Sodium Hydroxide (Caustic Soda)	1¾ ounces	52.5 grams

Dissolve chemicals in order given.

Use equal parts of A and B and develop for not more than two minutes at 65° F. (18° C.).

Cold water should always be used when dissolving sodium hydroxide (caustic soda) as considerable heat is evolved. If hot water is used, the solution will spatter with violence and may cause serious burns if the alkali spatters on the hands or face. Solution A should be stirred thoroughly when the caustic alkali is added; otherwise the heavy caustic solution will sink to the bottom.

Wash thoroughly after development and before fixing to prevent stains and dichroic fog.

When using the D-9 Caustic Developer, mix a small amount in a small tray or dish which is only a little larger than the 2 x 2 inch glass plate. Use developer only sufficient to cover the plate. Upon mixing the two solutions, the developer oxidizes quite rapidly and after eight or ten minutes, at the most, the developer should be discarded. In the meantime, the slides may be developed. As this is a strong and rapidly working developer, make certain that the positive plates are not overexposed, since fine details in a line drawing or a printed page will not show distinctly unless correct exposure has been made. However, with the correct exposure and the caustic developer, a brilliant contrast negative will result.

Using Projection Paper for Testing

When making film or glass slides, it is possible to use a bromide projection paper cut into small sizes and used in place of the film or

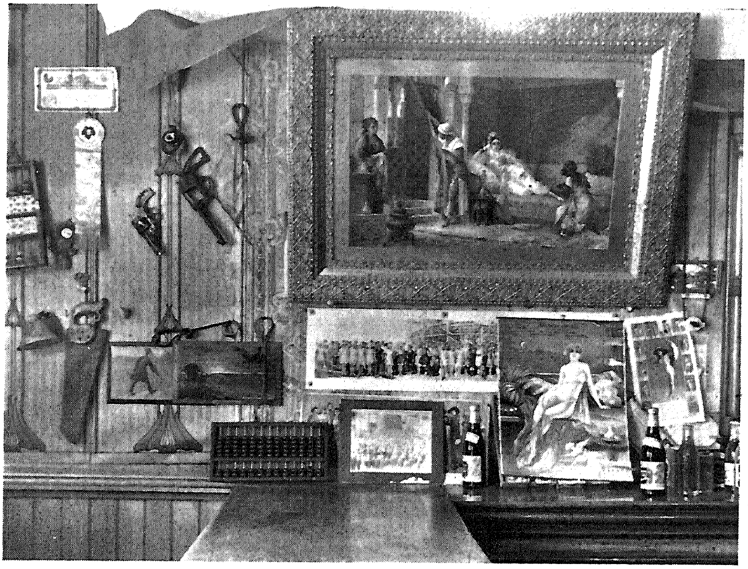


Fig. 150 Saloon of the Gold-Rush Days Willard D. Morgan

PRESERVING THE EARLY AMERICAN SCENE

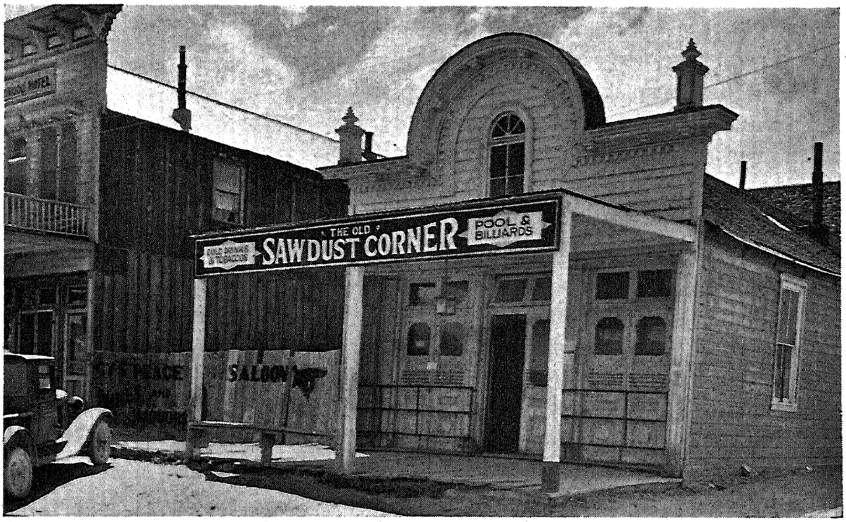


Fig. 151 Country Club of Gold-Rushers Willard D. Morgan

glass plate for testing the exposures. A paper, such as the Agfa Brovira medium, or contrast has a printing time very similar to positive film or glass plate emulsions. With a little experience, the proper ratio between the paper and the positive emulsions may be easily determined for this paper, as well as any other make of Bromide papers. Such a method of making tests is economical because a full glass plate does not have to be exposed in order to find out the correct exposure time. At the same time these contact paper prints may be used for indexing purposes or for cross references after the slides have been made. It is a good plan, in fact, to make a paper contact print of every negative which is made into a positive for projection. These paper prints are useful for classifying the pictures later. There is a special metal pressure plate which may be placed over the square rubber plate which is used in the Eldur Printer. This metal pressure plate permits the making of paper contact prints in the Eldur Printer. It is quickly removed when glass plates are to be made.

After each positive glass plate has been developed, it should be rinsed for a few seconds in fresh water and then placed in the hypo clearing solution for about eight to ten minutes. After clearing, the slide is then placed in running water and washed for one-half hour. When washing has been completed, wet a piece of cotton or use a wet viscose sponge for swabbing off both sides of the plate which is then placed in a drying rack in a location free from dust. A close-meshed linen cloth may be laid over the drying rack in order to keep out dust particles which may settle on the wet emulsion of the plate and later show up on the projection screen.

When all the slides are dry, they should be projected before binding in order to check on the quality. In case there are scratches, pin holes or other defects, the slide must either be touched up or discarded. Small pin holes and breaks in the emulsion can usually be eliminated by spotting with a fine brush and black spotting ink. The Chinese Ink stick, which may be purchased at most photographic dealers, is very handy for this purpose. Some slides may require opaquing around the principal object. This is easily done by painting with a good opaque solution which dries quickly. Slides showing machinery parts, and copies of irregular subjects which are to be shown without a background, will require this method of opaquing before binding.

Mounting the Finished Glass Slide

After the glass slide is dry, secure a clear cover plate together with a cut out mask and a package of lantern slide binding tape. The binding tape can be cut into four lengths of two inches each, or if preferred, one full length about eight and one-half inches long may be cut. Place the

cut out paper mask over the emulsion side of the positive in such a way that the clear portions of the positive surrounding the picture are covered. Next, place the clear cover glass, which has previously been washed and polished dry, over the mat and the positive plate. Hold both plates together and paste the paper binding tape around the edges. **Make sure that the emulsion side of the positive plate is always covered by the glass plate.** If the emulsion side is on the outside, it will quickly be damaged.

Film positives may be cut with scissors and bound between glass plates if desired. Some Leica users prefer this method since the pictures may be made at smaller expense. Two or three positives may be made of the same negative in case there is any doubt about the exposure. The best positive is then selected for binding between the two clear glass plates with the paper mask between. The film positive should be attached to the paper mask by one or two small pieces of the paper binding tape in order to keep the picture centered while binding. This method is especially recommended for the natural color films, such as the Agfacolor, Dufaycolor and Lumiere.

After the glass slide is bound, it should be spotted by placing a small white square of gummed paper or photo cloth in the upper right corner of the slide when it is in its correct position for projecting. In other words, hold the slide before you so that it looks correct. That is, the slide should appear in the same orientation as the original subject. Then, turn the slide so that the subject is up-side-down with the emulsion side facing toward you. Place white spot on the upper right corner of the slide. When the slides are being projected, it is very easy to place them in the projector in their proper position without difficulty, simply by watching the reference spot.

All glass slides spoiled by wrong exposure, developing, or any other cause, should be saved and used for cover glasses later. These discarded slides may be soaked in hot water and strong soap in order to soften and remove the emulsion. A razor blade is good for scraping off the emulsion. Give the glasses a final wash in another soap and water bath and then wipe thoroughly dry with a clean linen cloth. The glasses are now ready for use in binding the good lantern slides.

Still another method of preparing film positives for projection is by mounting three positive films between two clear glass plates which measure 35 x 120mm. These plates are matted and bound, similar to the 2 x 2 inch glass plates. The Udimo Projectors have a special slide holder for accommodating this longer sized plate. In the case of stereo positives, this method of binding is excellent as the Stereo Viewer accommodates the 35 x 120mm slide.

Making Film or Glass Slides by Projection

My favorite method of making film or glass slides is by using one of the Leica enlargers. The negative is placed in the enlarger with the emulsion side facing down as usual, while the unexposed film or glass plate is placed on the baseboard after exact focus has been obtained on another focusing plate. When unexposed positive film is used in the Eldia Printer, the top plate of the printer is clamped shut as usual. However, the picture is projected through the glass plate upon the positive film. Before making the exposure, focus the negative upon

a white area the exact size of the Leica negative and also in the exact plane of the film in the printer. A block of wood may be cut for this purpose or two printers may be used.

Film positives may also be made by using the Leica camera loaded with positive film without a lens. The picture is focused from the enlarger directly into the camera after the focal plane shutter has been set at time exposure. Once the correct focus and position have been determined, the entire strip of film may be exposed. A thin block of wood 3½mm thick (the exact thickness between the back of the Leica and the face of the pressure plate) may be used for focusing the image before the camera is placed into position. The face of the wood should be painted white and the exact frame size of the picture ruled off in black crayon for a guide when focusing.

A single frame 18 x 24mm film positive may be made by reduction from the Leica size 24 x 36mm negative. The Eldia Printer equipped with a single masking window may be used for this purpose. The Leica Enlarger is equipped with a 6cm extension tube between the 50mm lens and the focusing mount. In this way, it is easy to reduce the Leica negative to single frame size. All Leica projectors are equipped for single frame as well as double frame projection. As there are many projectors available for single frame pictures only, this method of making positives will naturally be of great value for such projectors.

When using the 2 x 2 inch glass plates, it is simpler to place one of the undeveloped plates on the paper easel of the enlarger. The plate may be pushed into the corner of the easel in such a way that a second plate may be replaced after the image has been centered on the focusing plate which contains a penciled outline 1 x 1½ inches in size, representing the size of the Leica negative. If preferred, the picture area may be made 3 x 4cm in size and later the picture masked off by using the short strips of lantern slide binding tape. This 3 x 4cm size can be projected only in the Udimo projectors.

An orange filter is convenient to use while making glass slides. Such a filter may be thrown across the projected negative image in order to make certain that the unexposed glass plate is properly centered before the exposure is made.

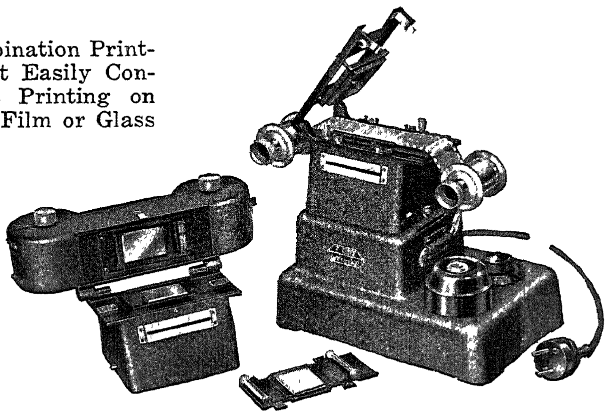
The important part of the Leica negative is easily centered upon the glass plate. All the unessential parts of the negative are eliminated because the projected picture may be made larger or smaller in order to eliminate certain parts of the negative. At the same time, it is not difficult to shade part of the picture during exposure in order to bring

out certain parts of the positive, such as, a dense sky, or possibly some other portion of the negative may have a strong highlight which should be printed longer. In fact the projection method of making glass slide positives is the ideal way in order to insure the best results.

In some cases, it is necessary to make 3¼ x 4 inch standard lantern slides for use in the larger projectors. Such slides are made by using the Leica enlarger and following similar methods which apply to the smaller 2 x 2 inch glass slides. If the original Leica negative is developed properly, it is possible to make 3¼ x 4 inch glass slides which will produce beauty and brilliance equal to slides made from larger negatives when projected.

When using the Valoy or Focomat enlargers for making film or glass positives, it is necessary to use either a 3cm or 6cm extension tube between the 50mm lens and the focusing mount of the enlarger. When the 3cm tube is used, keep the lens barrel pulled out and locked in position. However, in case the 6cm tube is used the lens barrel may be pushed in as far as it will go. The correct focus is obtained by turning the focusing mount of the enlarger. Naturally, other extension tubes or any combination of tubes may be used depending upon the results required. In case a longer working distance is required between the lens and the positive, a 6cm tube and the 90mm Elmar lens may be used very successfully.

Fig. 152 Laver Combination Printer. A complete Unit Easily Convertible for Contact Printing on Paper, Paper Strips, Film or Glass Slides



Operating the Combination Professional Printer

When a more universal positive printing outfit is required, the Laver Combination Printer is recommended. The important features of this printer are listed as follows:

1. Single frame and double frame film slides may be made.

2. Single frame, Leica size double frame, 3 x 4cm and 4 x 4cm glass plate positives may be made by using a supplementary plate printing attachment.
3. All metal construction, with enclosed lamp housing, containing a 15-watt bulb for making the exposures.
4. Rheostat control for varying light intensity.
5. A small red light burns continually in the lamp housing in order to show the proper exposure, or density of each negative.
6. Contact button for turning on the white light for making the exposure.
7. Slots on each side of the printer permit the insertion of a thin piece of cardboard for use in shading parts of negatives during the exposure.
8. Film housing will hold up to 35 feet of positive film. The exposed film may be cut off and developed as used.
9. On each side of the glass plate, under the negative, there is a small line drawing, showing which way the negatives should be printed in order to appear in the finished positive film roll in the proper upright or horizontal positions.
10. When the positive film chamber is moved out of position, a metal plate automatically covers the exposed portion of the positive film. **Naturally the printing should be done under a red safety light in the darkroom.**

The positive film is loaded into the Laver Printer by removing the top portion of the film housing and rolling the film directly upon the spool opposite to the ratchet spool, similar to the one in the Eldia Printer. Make certain that the film is wound with the emulsion side out when loading and attach the free end to the take-up spool which is wound in such a way that the film emulsion will be on the inside. In other words, the film passes over the ratchet wheel and down under the take-up spool. As the film is advanced, a distinct click will be heard for each single frame space. Two of these clicks represent the length of a Leica negative. After the film has been inserted, place the upper part of the housing back into position.

The making of film and glass slides by contact printing is carried out by methods similar to those previously explained.

In using either the film slide attachment or the glass slide attachment on the Laver Printer, it is possible to see picture numbers or special marks which may be made on the film margins for reference when selecting the proper negative for making the positive printing.

Using the Belun Attachment

Still another method of making positives is by using the Belun 1:1 copy attachment. For this set-up secure a light box for illuminating the negative which is to be copied directly upon the positive film which has been loaded into the Leica camera. A 15-watt bulb will be sufficient for illumination. Set the Belun copy attachment over each negative to be copied and make the exposures. A few test exposures should be

made before running through the entire film. A short length of positive film may be loaded into the camera for making the test shots. By using the Belun attachment sections of larger negatives can be copied and made into positive film slides for projection also. Then by using the Sliding Focusing Copy Attachment any sized negative can be copied for positive film slides.

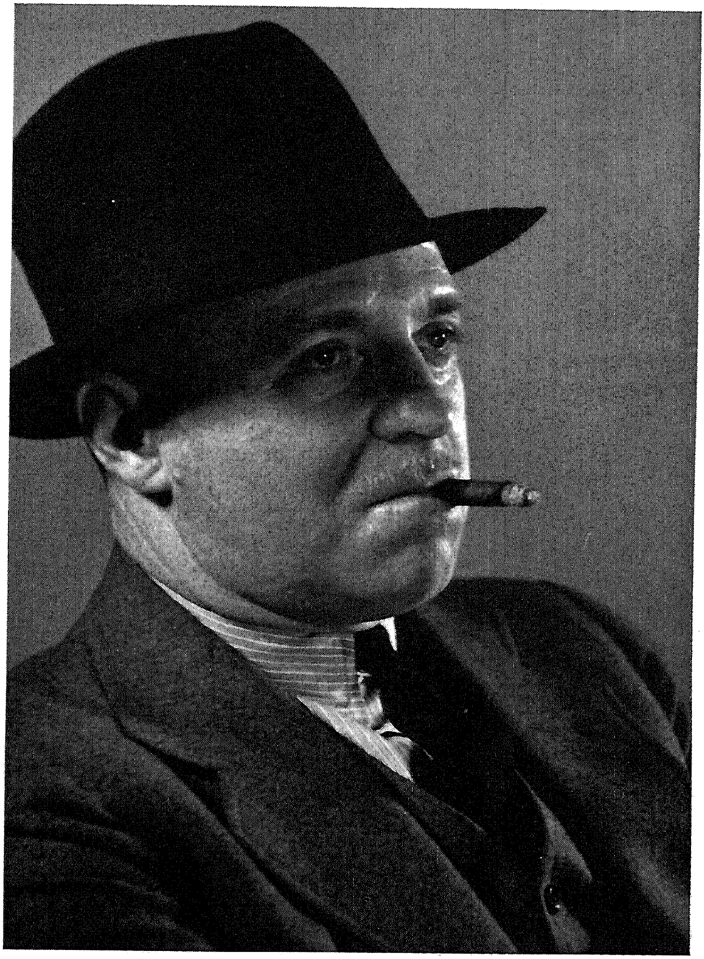


Fig. 153 My Friend Lionel — Henry M. Lester

Fig. 155 Sky Rockets E. Scott Pattison
Elmar 50mm lens, wide open, 1 minute exposure

PROJECTING LEICA PICTURES

WILLARD D. MORGAN

CHAPTER 11

After the positive film or glass slide has been made, the next step is to show the finished pictures on a projection screen. In doing this, it is necessary to select one of the projectors described later in this chapter.

By projecting Leica pictures, you have an opportunity to show one picture to a group of friends who may be assembled for the occasion. In this way, all can be united in viewing one picture at a time and also in talking about each picture as it is shown. Thus, a very profitable half hour or an entire evening may be spent. Each picture is thus presented in its fullest advantages of large size and with its three dimensional effects which come nearest to interpreting the original scene.

In the field of visual education and industrial selling, the use of positive pictures for projection is of immense value. In the industrial sales field, for example, it is possible to use the Leica Camera to photograph actual manufacturing processes and later arrange these pictures in slide form for projection. For example, there is a large industrial firm which uses the Leica Camera very successfully by collecting the latest developments and uses for their product from different state managers. These pictures are then assembled and printed along with appropriate titles on film strips. The duplicate strips are later mailed out to the various branches for the regular sales meeting of the district salesmen. Thus each district is kept in constant touch with all the developments throughout the country.

The Various Projectors Available

There are five different Leica projectors available for showing Leica positives. These projectors range from the small Umino projector to the large 400-watt Udimo projector. In selecting the proper equipment for your purpose, it is important to consider the various specifications of each projector. Two of the most generally used projectors are, the small miniature Umena Projector, and the Udimo 100 Projector. The Udimo 250 and Udimo 400 projectors are of

special value for use in projecting natural color pictures and also for use in larger rooms where a longer projection distance is required.

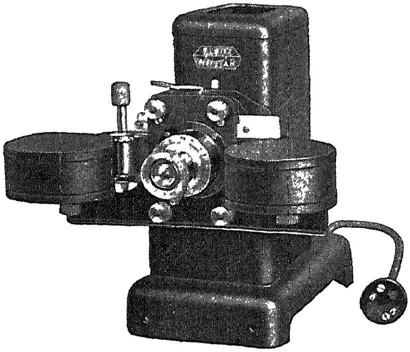


Fig. 156 Udimo-100 Projector, Shown Complete with Camera Lens, Film Magazines and Transport Gate

The Udimo 100 Projector

The Udimo 100 Projector is considered to be the standard model projector which is used by many Leica owners. The specifications and directions for using this projector are given as follows:

1. Height, 9½ inches, width of base, 5 inches, length of base, 7½ inches.
2. Bayonet socket for holding 100-watt prefocused projection bulb.
3. Detachable heat absorption screen. When glass slides are being projected, this heat filter may be removed, thus slightly increasing the brightness of the screen picture.
4. The condenser of this projector is made up of three elements, the front element being interchangeable for use with lenses of various focal lengths. This system insures the full illumination of every picture projected with the various lenses providing the proper front condenser is in position. Complete information about the interchangeable condensers is given later.
5. The top cover plate of the projector housing may be removed when the tubular projection lamp is to be changed. When removing the lamp, simply pull directly out of the socket. When placing a new lamp in position, make certain that the filaments are parallel with the condenser system.
6. The entire lamp mounting may be removed by turning the projector up-side-down and removing the three large screws which hold the bottom plate in position. In case the central lamp housing is out of alignment, proper centering may be done by adjusting the set screws on the base plate.
7. The intensity of the projected positive is increased by means of a mirror reflector mounted at the rear of the projection lamp.
8. The film slide attachment which is mounted on the front part of the projector may be rotated in order to show horizontal and vertical pictures in their proper orientation. There is a small spring catch mounted just above the revolving attachment. This catch may be re-

leased when the attachment is changed to a vertical or horizontal position.

9. The various slide masks may be used for showing film or glass slide positives in various sizes, from single frame up to 4 x 4cm. All these masks and slides are quickly interchangeable in the film or glass slide attachment which is mounted in front of the projector and secured into position with four knurled knobs.

10. All the Leica lenses with the exception of the 35mm wide angle may be used with this projector as well as the Udimo-250 and Udimo-400 Projectors. There are also two special 80mm and 120mm projection lenses available for these projectors. A special base tube or receiving socket is used with the 80mm and 120mm projection lenses for attaching to the projector. All the Leica lenses are screwed into the film or glass slide attachment directly without the use of any intermediate tubes.

11. When loading the positive film slide into the Udimo film slide attachment, proceed as follows:
    a. While facing the projector from the front, remove the left film drum and draw out the film transporting gate. Make certain that this gate is thoroughly cleaned. The front plate may be removed by lifting out from under the two springs which hold it into place. At the same time, the lower glass plate may be slid to one side and removed by slightly raising the spring band which will be seen along the top side of the film gate. This plate may be replaced by a plate with single frame window in case single frame film slides are to be used. Otherwise, clean the original plate and place it back in position along with the film transport gate.
    b. When replacing the film transport gate, push it into its slideway as far as it will go. While facing projector, this gate is pushed into position from the left side, the same side through which the positive film strips are started.
    c. Replace the left film housing and insert the positive film roll into this housing with the beginning of the roll projecting through the guide which opens directly into the film sliding gate and is transported through this gate by turning the ratchet wheel.
    d. The turning knob of this ratchet wheel must be pressed down each time the film is transported, otherwise, the film will not turn. After the film has been transported, raise the turning knob. In doing this, the glass pressure plate automatically presses against the film and holds it in a perfect plane during the projecting. When the turning knob is depressed, this glass plate automatically separates at the same time the film is being transported. This precaution prevents any possible scratching of the film.
    e. As the film is turned through the transport gate, it automatically enters the opposite film chamber on the right and winds into this chamber.
    f. Start the positive film through the transporting device with the emulsion side facing the projection bulb being sure that the horizontal images of the film are inverted or upside down.

12. There are four interchangeable condensers for use with the three Udimo Projectors. These condensers are supplied for use with the various lenses of different focal lengths. Each condenser has marks on the side, indicating the focal length of lenses required for the particular condenser. The exact specifications of each condenser are given as follows:
    a. **Interchangeable Condenser** marked "5" for use with Summar, Hektor and Elmar 50mm lenses, for use with Udimo 100 and Udimo 300 Projectors.
    b. **Interchangeable Condenser** marked "5VIIK" for use with Summar, Hektor and Elmar 50mm lenses for Udimo 400 Projector only.
    c. **Interchangeable Condenser** marked "7.3-8-9" for use with Leica lenses Hektor 73mm, Elmar 90mm, and special projection lens Milar 80mm focus.
    d. **Interchangeable Condenser** marked "10.5-12-13.5" for use with Leica lenses Elmar 105mm, Elmar 135mm and special projection lens Dimax 120mm focus.
13. The special 120mm projection lens is known as the Dimax, while the 80mm special projection lens is known as the Milar.
14. The Glass Slide Changer as illustrated is excellent for use when showing the 2 x 2 inch glass slides in the Udimo Projectors. This Slide Changer may be used in the special glass slide holder, or it may be used in the Film Slide Attachment after the two film drums have been removed.

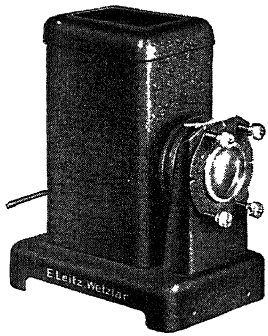


Fig. 157 Udimo-250 Projector. Illustration Shows Lamp Housing Only. All attachments are Interchangeable with the Various Udimo Projectors

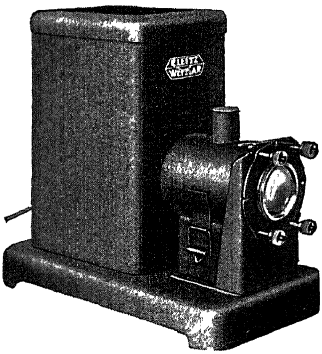


Fig. 158 Udimo-400 Projector. Illustration Shows Lamp Housing Only

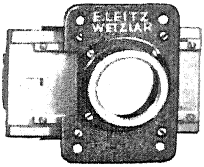


Fig. 159 Glass Slide Attachment, Interchangeable for all Udimo Projectors

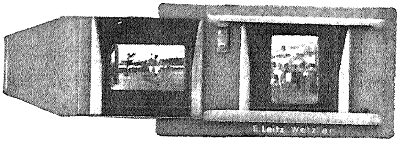


Fig. 160 Glass Slide Holder, Interchangeable for all Udimo Projectors

All the film and glass slide attachments are interchangeable for use on the Udimo 100, Udimo 250 and Udimo 400 projectors. The main differences in these projectors are in the lamp housings. 100, 250 and 400-watt projection bulbs are used respectively in each Udimo Projector. The height of the Udimo 250 Projector is 11½ inches, while the width of the base is 6 inches and the length 9 inches. The Udimo 250 has a special self-contained heat filter in the condenser system. The height of the Udimo 400 Projector is 12½ inches, while the width of the base is 7½ inches and the length 13½ inches. The Udimo 400 Projector is equipped with a special water cooling jacket which should be filled with distilled water before using.

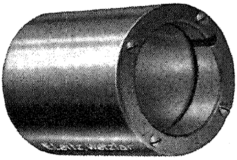


Fig. 161 Base Tube for Attaching Special 80mm and 120mm Projection Lenses, Interchangeable for all Udimo Projectors

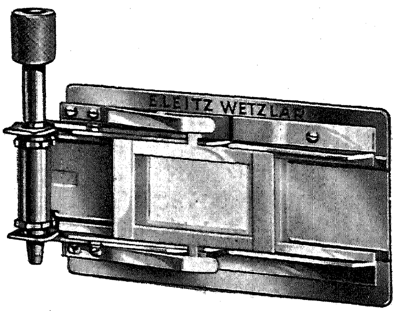


Fig. 162 Film Transport Gate, Interchangeable for all Udimo Projectors

A special Elevator Plate may be attached to any of the Udimo Projectors. There are two small threaded holes in the base at the front of each projector for attaching the Elevator Plate. This Elevator Plate may be attached to the base of either projector and set at the proper position so that the projected picture is perfectly centered on the projection screen. The film and glass slide attachments are all interchangeable for the various projectors.

Table showing screen areas for various projection lenses.

Screen Distance and Screen Areas in Feet

Lens	6 ft.	9 ft.	12 ft.	15 ft.	18 ft.	21 ft.	24 ft.
Elmar f:3.5 50m......							
Hektor f:2.5 50m......	3.9×2.7	6×3.9	8.1×5.4				
Summar f:2 50mm....							
Hektor f:1.9 73m......		4.5×3	5.7×3.9	7.2×4.8	6×9		
Elmar f:4 90mm......		3.6×2.4	4.5×3	5.7×3.9	6.6×4.5	8.1×5.4	
Elmar f:6.3 105mm....			3.9×2.7	5.1×3.3	6.3×4.2	7.2×4.8	8.1×5.4
Elmar f:4.5 135mm....			3×2	3.6×2.4	4.5×3	5.4×3.6	6.3×4.2
Milar 80mm		3.9×2.7	5.4×3.6	6.3×4.2	8.1×5.4	6.3×9.5	7.2×10.8
Dimax 120mm			3.6×2.4	4.2×3.7	5.4×3.6	6.3×4.2	7.2×4.8

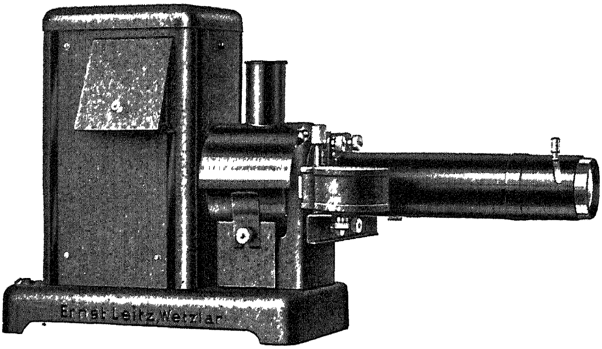


Fig. 163 Udimo-750 Projector complete with 250mm projection lens and special film transporting device which accommodates film lengths up to 70 feet

The Udimo-750 Projector

The Udimo-750 Projector is really a universal projector which can be used for screen distances between 10 and 100 feet or more. All the Leica lenses with the exception of the 28mm and the 35mm can be used with this 750-watt projector. In addition, there are the 80, 120, 150, 200, and 250mm projection lenses to select from. The high light intensity makes it possible to project color pictures upon a large screen and still retain the brilliance required.

There are six different interchangeable condensers available for all the various projection lenses. The three additional condensers not listed on page 240 are added as follows:

e. **Interchangeable Condenser** marked "15" for use with the 150mm Dimax projection lens.
f. **Interchangeable Condenser** marked "20" for use with the 200mm Dimax projection lens.
g. **Interchangeable Condenser** marked "25" for use with the 250mm Dimax projection lens.

As a supplement to the table on page 242 the following projection distances and screen areas will give additional information of value:

Lens	35 ft.	60 ft.	80 ft.	100 ft.
Dimax 150mm.......	6 × 9	10 × 14½		
Dimax 200mm.......		7½ × 11¼	10 × 14½	
Dimax 250mm.......		6 × 9	8 × 12	10 × 14½

All measurements are given in feet

The Udimo-750 has a special heat filter and water jacket cooling chamber to prevent the overheating of positive films during projection. All the interchangeable accessories used with the other Udimo projectors may also be used with the Udimo-750. A special film attachment may be used which accommodates all film lengths up to 75 feet.

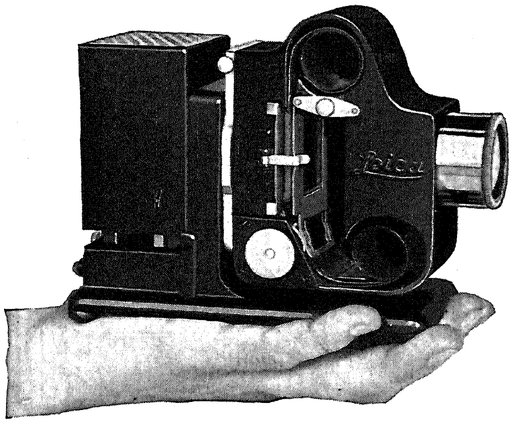


Fig. 164 The Umino (50 watt) or Umena (100 watt) Miniature Projector for Single and Double Frame Film Slides or Glass Lantern Slides

The Umino and Umena Miniature Projector

One of the simplest and most compact projectors available for showing Leica film or glass positives is known as the Umino Projector which contains a 50-Watt projection bulb. This projector is so small that it can easily be carried in a brief case along with a supply of positive film or slides. As this projector has so many distinct ad-

vantages, it is recommended for use by all Leica users who are interested in projecting their pictures. When the Umino projector is equipped with a 100-Watt projection bulb it is referred to as the Umena Projector. The specifications and directions for using this projector are given as follows:

1. Height 5 1/2 inches, length 7 inches, width 2 1/2 inches, weight 2 1/3 lbs.
2. 80mm projection lens in focusing mount, 50 or 100-watt projection bulb available.
3. Six-volt bulb may be used with ordinary automobile storage battery when the usual electric current is not available.
4. Front film housing may be rotated for showing vertical or horizontal pictures after loosening the set screw No. 1. The complete front rotating portion of the projector may be removed after loosening the set screw No. 8. After this set screw is loosened, simply raise the front attachment and remove from its position.
5. When a 100-watt bulb is used, a heat absorption filter is inserted into position as indicated by No. 5. A spiral spring No. 4 is removed or replaced for holding the heat filter in its proper position.
6. In case the condensers No. 6 and No. 7 are to be removed for cleaning, it it only necessary to remove the spiral springs which hold them in place.
7. When loading the strip of positive film into the Umino Projector, unhook the clamp No. 11 and swing out the pressure plate No. 12. The film roll may be inserted into the film chamber No. 14, while the free end of the film roll is passed down under the metal guide of the lower chamber. After making certain that the perforations of the film mesh with the cogs on the turning rachet wheel, close the hinged pressure gate No. 12.
8. After the film has been placed in its proper position, turn the film transporting knob No. 20 slowly until the first frame of the film strip comes into exact position on the projection screen. This frames the first picture and from then on the knob is pulled out and turned for each picture. A slight click is heard as the knob is turned. Each click represents a space of a single frame positive, thus two clicks are necessary to place each Leica size positive in position.
9. When 2 x 2 inch glass slides are to be used, the front film pressure plate No. 12 is removed. In doing this, simply unscrew the knob

No. 17 part way until the cross plate No. 18 separates from the glass pressure plate No. 12. Then, remove the glass plate entirely. Next, draw out the back glass pressure plate No. 9. In this way space is left for inserting the 2 x 2 inch glass slides which may be pushed through as required. When using the glass plates it is not necessary to revolve the front housing because the glass plates have the pictures already mounted in either horizontal or vertical positions.

10. When changing the projection bulb, loosen the set screw No. 10 and then raise and remove the lamp housing No. 9. The interior metal lamp housing is pushed back, thus leaving the projection bulb free for changing.

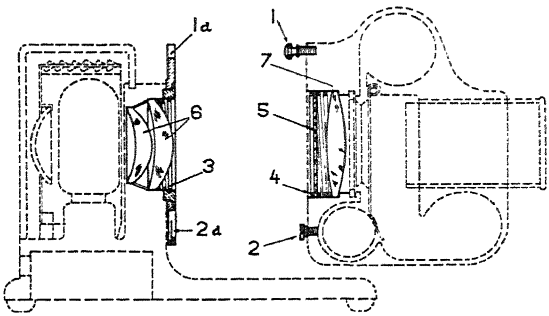


Fig. 165 Cross section of Umino or Umena Miniature Projector, Showing Detail of Optical System

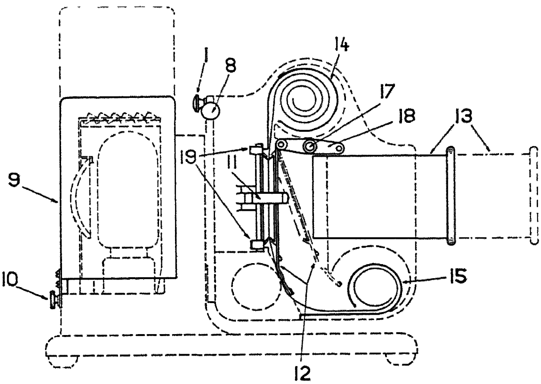


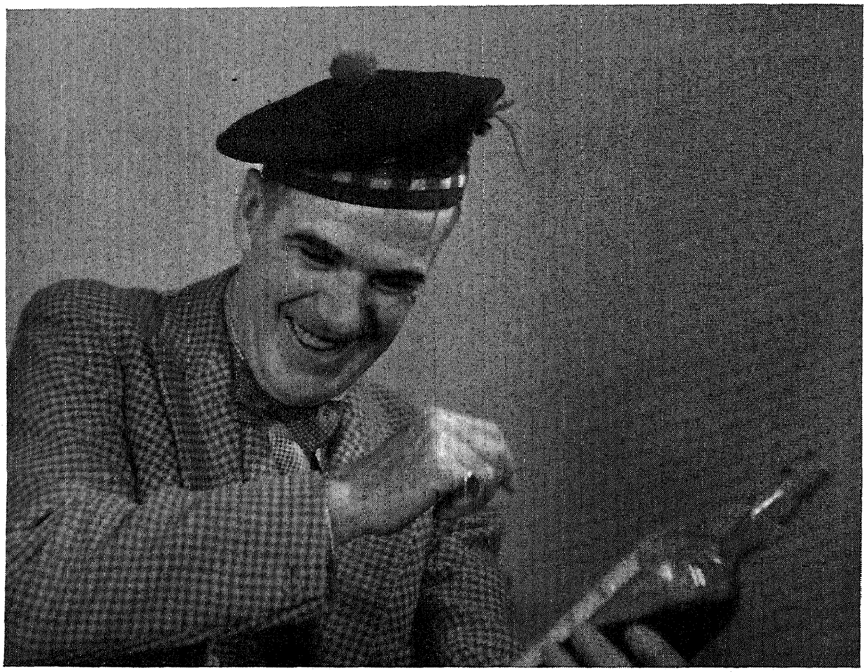
Fig. 166 Cross section of Umino or Umena Miniature Projector, Assembled, Ready for Projection

When using the Umino Projector, make certain that the film positives have been hardened in order to prevent scratching during projection. If the positives have been properly processed, danger of scratching the film slides during projection will be practically eliminated.

Titles for Film

Whenever possible, try to include printed titles in your film strips. A few titles scattered through a film strip will give added interest as well as information to the people who are viewing pictures. The strip can start with a special title and short description about what the pictures will cover. Titles are easily made by using one of the copy attachments referred to in the chapter on Copying with the Leica Camera. Boards containing movable letters are available for setting up titles.

If a title board cannot be secured, simply use a black slate and letter the wording with chalk. Make the photograph and then erase the lettering for the next sub title. In fact, titles might even be lettered across actual Leica enlargements which may present an interesting background. With a lettering board many interesting titles may be worked up for use with your film slides.



Advertisement — Rudolf Hoffmann

Storing Positive Pictures

All film slides and glass slides should be kept in containers free from dust. Such containers may be secured from the regular photographic dealers, or, if preferred, special containers can be made to cover any individual requirements. The small metal cans with covers on which the titles of the film slides may be written are excellent. These tins may be purchased on the market. Another way to keep film slides is by using the regular film storage boxes which contain cross-sections with spaces for about 25 rolls of film. The glass slides are easily kept in small boxes with hinged lids.

As your film and glass slide library grows, it will be necessary for you to develop a special indexing system so that any picture may be located instantly when desired. In the case of film slides, it is convenient to make paper contact prints of every picture on a single strip of film. These contact pictures are then mounted onto an index card which contains titles, numbers and complete information about that particular film roll. Contact prints of the individual glass slides may also be made and mounted on individual indexing cards, along with the proper title and descriptions. In the case of the glass slides, it is very easy to group the subjects under various classifications, such as, buildings, street scenes, birds, boats, portraits, flowers, or any other subject. As the glass and slide collection grows, a valuable index and cross reference system may be built up. The slides are then available for instant use for showing in the home or in preparing special lectures or demonstrations.

UMINO AND UMENA PROJECTION TABLE

Distance in feet between Umino or Umena and projection screen	Screen Image Leica size	Screen Image single frame size
6	2 ft. 5 in. x 1 ft. 7 in.	1 ft. 7 in. x 1 ft. 3 in.
9	3 ft. 7 in. x 2 ft. 3 in.	2 ft. 3 in. x 1 ft. 8 in.
12	4 ft. 10 in. x 3 ft. 2 in.	3 ft. 2 in. x 2 ft. 5 in.
15	6 ft. x 3 ft. 10 in.	3 ft. 10 in. x 3 ft.
18	7 ft, 2 in. x 4 ft. 8 in.	4 ft. 8 in. x 3 ft. 6 in.
21	8 ft. 4 in. x 5 ft. 6 in.	5 ft. 6 in. x 4 ft. 2 in.
24	9 ft. 6 in. x 6 ft. 3 in.	6 ft. 3 in. x 4 ft. 8 in.

Fig. 168 Dachshunds
(Not a Stereo!)

Ivan Dmitri

STEREOSCOPIC PHOTOGRAPHY

HENRY M. LESTER **CHAPTER 12**

Our keen appreciation of realism in photography finds its fullest expression in our fondness for color pictures and stereoscopic views. The latter, known among graphic arts as three dimensional photography, is, for the time being the only method of rendering pictures so that the subject looks round and plastic. It is unfortunate that at present we are unable to lend this plasticity to single picture views obtained by ordinary, two dimensional photography, which always has, and still is endeavoring to assist our imagination to see things in pictures as we are accustomed to see them in life. By means of lighting, suitable backgrounds and skillful placement of the object within its environment, photographers are trying more or less successfully to give their pictures the effect of roundness and depth. But so far, photography has not been able to find a substitute for that lifelike rendering of depth in anything but the double image secured by viewing the subject from two points.

There is nothing new about a stereo camera. But the manner in which stereo views are obtained with a Leica camera is a decided departure from the old-fashioned methods of stereo photography. Before the Leica made its entrance into this field, a stereo camera had to have two lenses. In better cameras of this type these lenses had to be of the **matched** type, synchronized as to lens aperture and shutter action. The stereo feature introduced by the Leica consists of taking stereo pictures with one lens only.

The problem was solved with remarkable simplicity. Two prisms, placed about 70mm apart along a horizontal axis are made to act as small periscopes, bringing the two respective images together in front of the regular Leica lens. Each of these two images enters the camera and reaches the film plane through its respective half of the lens. Thus two separate images are formed upon the film, each measuring half of the Leica frame: 18x24mm. There is no dividing line between these two images: they merely join each other, forming a narrow *fade* into one another, thus using the maximum space available.

A negative thus formed is made into a positive transparency by contact printing upon 35mm positive film without any of the customary

reversal of images. The positive is then viewed through a slightly modified form of the same periscopic double prism, where the process is reversed. Here the images are picked up from the double frame separately, and carried to two eyepieces, thus giving full stereo effect.

The Leica method of stereo photography has also the advantage of seeing stereo pictures at their very best because of the added luminosity, plasticity and brilliance of viewing positive transparencies instead of paper prints. All this gives the picture an added sense of realism. Of course, if paper prints are preferred, they may be made just as easily by enlargement to the size desired.

The Stereo Equipment

The Stereoly attachment consists of two units: the photographing unit, which is placed over the standard 50mm lens, and held in place by means of a small arm fitting into the camera clip; and the viewing unit, which has adjustable eyepieces and a slotted channel for the film. The viewing unit can be held in hand or attached to a convenient stand. The Stereoly taking unit has its own view finder, which replaces that of the camera. Since each of the two pictures obtained is only half as large as the regular Leica frame, only half the area covered by the 50mm lens is available. The Leica must always be held horizontally when used with the Stereoly, which will result in two vertical images. The camera should not be used vertically.

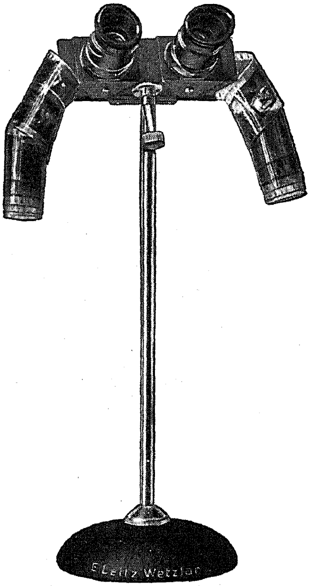


Fig. 169 Stereo Viewer, on Stand, for 35mm Leica Stereo Positives

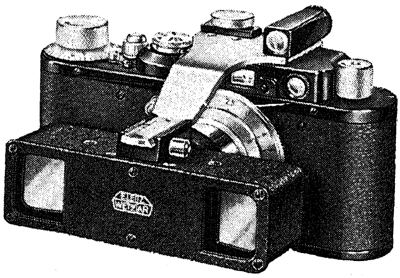


Fig. 170 Stereoly Photographing Unit for Stereoscopic Photography with Hektor, Elmar, and Summar 50mm Lenses only

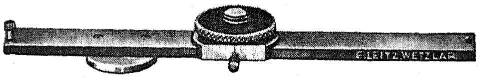


Fig. 171 Stereo Slide Bar, for Stereoscopic Photography when making two separate negatives

Taking Stereo pictures with the Leica is no more complicated than taking ordinary pictures. The Stereoly is placed before the lens, given a simple adjustment described in the instructions accompanying each instrument, and one is ready to take pictures. The exposure variation of the Stereoly is almost negligible, if one considers the latitude of modern film emulsions. To be sure, the exposure factor is not constant. It varies from the requirement of an exposure fifty per cent longer with the lens set at f:3.5 to an increase of some ten per cent only, when the lens is stopped down to f:12.5. As a matter of general practice, it is recommended to take stereo pictures with the lens stopped down to f:6.3 or f:9. Lens openings larger than these do not yield sufficient depth of focus for stereo pictures, while those smaller than f:9 are apt to cause vignetting of images under certain conditions. The Stereoly unit does not by itself cause any unsharpness of pictures, but to avoid pictures lacking definition and detail, so important in stereos, all exterior glass surfaces should be kept scrupulously clean at all times, and free from finger marks above all.

Filters for Stereo Photography

Filters may be used in connection with the Stereoly attachment if they are in the standard Leica slip-on mount. They are simply placed over the lens, and the Stereoly is attached over the filter. Since the aperture of the lens cannot be changed nor can the filters be removed without first removing the Stereoly from the camera, it is suggested that the lens be operated always at the same stop when used for stereo pictures. Filters should be used as judiciously as in any other form of Leica photography. It should be remembered that filters, as their name implies, are not there to add anything to the pictures, but merely to remove something that may be objectionable. Frequent reference to the special chapter on this subject may, we hope, result in a more reserved and more appropriate use of filters in general.

In certain instances where special filters used for definite effects are not available in Leica mounts, and cannot be made to fit on account of their excessive thickness, they may be used (if available in pairs) by being fastened to the front part of the Stereoly taking unit in such a way that they completely cover the two front apertures. It may not be amiss to say that when this is resorted to, both filters must be identical.

Sunshades and Film

Experiments have shown conclusively that stereo pictures secured with the aid of sunshades were quite superior to those obtained without them. They seem to be sharper, clearer and more brilliant and have a better definition throughout. The proverbial ingenuity of Leica users should find here another field of application. The writers have used successfully two standard Leica sunshades of the inexpensive kind fastened to each end of the Stereoly unit by means of scotch tape. On another occasion, a 10 inch length of 1½ inch black scotch tape wound all around the front edge of the Stereoly, protruding about an inch, served the purpose admirably.

Stereoscopic photography with the Leica is so simple that it may be said that there is actually no difference between this form of photography and any other form of Leica photography, except for the accessories required. For this reason the selection of film, developer, filters, and other factors should be made exactly as one would for any other form of work. Fineness of grain is not more, but certainly not less, important than in any other form of Leica photography. Careful handling of negative material is just as imperative. Absence of scratches, abrasion marks, reticulation

and all other proofs of carelessness is just as important in stereo photography as it is, say, in portraiture.

Selection of film should be made in a similar way to that of ordinary photography. Orthochromatic film of fine grain should be preferred by beginners, and those who are not accustomed to the latitude and softness of panchromatic emulsions. Those, however, who know and like panchromatic films will prefer them for stereoscopic photography just as they do for other types of work.

It is quite feasible to produce direct stereo transparencies on negative stock by reversal. For this purpose, the newest Agfa film, the Reversible Superpan is very much to be recommended. Generally, regular negative materials of the modern type cannot be used for reversal on account of their gray nonhalation backing. However, it should be realized that although reversal is one of the simplest ways for securing transparencies, it is by no means the most practical procedure: through reversal one loses the negative, and with it the only way for making additional prints. After reversing a negative, one has nothing but that one positive on hand, and production of additional positives, while not impossible, is difficult and rather complicated. Even with the greatest care, positive films do get scratched and damaged in handling and pulling through the Stereo Viewing Attachment. Because of this fact, one should have the means of securing another positive print easily and economically. All positive transparencies should receive an adequate hardening treatment by any of the methods described in the chapter dealing with this subject.

Stereo Color Pictures

As far as black-and-white photography goes stereo transparencies represent probably the most realistic form of reproduction. But natural color transparencies for stereoscopic viewing mark the goal (at least at present) of realism. With the advent of KODACHROME, the new natural color film recently made available for the Leica camera by Eastman Kodak Company direct color stereoscopic photography with the Stereoly Attachment is not only practical but extremely simple and easy. No color filters being required for use with Kodachrome film, there being one type of film for daylight and another for work in artificial light—there is no longer any impediment to simply attaching the Stereoly to one's Leica, stopping down the lens and proceeding to photograph in natural color as one would to make black-and-white pictures. Kodachrome Haze filters, if one wishes to use them for distant views, should be used according to suggestions made on the preceding page.

The handling of Kodachrome films is described in a special chapter of this volume (Chapter 14). No other special knowledge nor equipment is necessary to secure excellent stereo transparencies in natural, brilliant colors from the very first roll of Kodachrome film used. The same roll of film can, of course, be used for both stereo and standard pictures. After the film comes back from processing

the respective frames are cut apart and mounted either for projection or for viewing in the Stereoly Viewing Attachment.

The emulsion speed of both types of Kodachrome Film has recently been so substantially increased that perfectly exposed pictures are easily obtained at the f:6.3 aperture recommended for work with the Stereoly Attachment. The film is processed by Eastman Kodak, the cost of processing being included in the original purchase price of the roll. This should be welcomed by many miniature camera workers as it relieves them of the necessity to put their color films through a tedious and rather complicated procedure.

Protecting the Stereos

Stereo transparencies of any intrinsic value that cannot be duplicated should be handled with particular care. Any stereo transparency may be bound between two thin plates of cover glass and thus assured comparative permanence and security from scratches, abrasion marks and finger marks. This precaution would apply particularly to color transparencies, where negatives are not available, since they are obtained by means of reversal. For this reason, color transparencies should be bound in glass as soon as they are dry and ready for viewing. One has the choice of binding them into individual frames, or, better still, into strips of three frames each. Special cover glass plates are available for this purpose, measuring 35mm x 120mm, and their use cannot be too strongly recommended, not only for color transparencies, but also for any black and white pictures which are worth having. In such bound form they become comparatively permanent and most convenient to handle and to file.

While the Stereoly may be used for all forms of stereo photography, both indoors and outdoors, it is primarily intended for work without a tripod, for action pictures, landscape work, and all such subjects as require rather short exposures. A somewhat simpler accessory is available for stereo photography of still life, table top photography, three color separation work, etc. This accessory is known as the Stereo Slide Bar: a metal bar about 6 inches long with an engraved scale and slide mounted upon it. By means of a set screw the slide may be placed anywhere along the bar. The Stereo Slide Bar is firmly secured to a rigid tripod either of the field or table top variety. The camera is fastened to the slide and one exposure is made with the camera at one end of the bar. Then the camera is quickly moved to a predetermined position at the other end of the bar, and

the second exposure made. Thus, the set of stereo pictures is secured upon two full frame negatives, which may be made either into transparencies or prints. This method, while not as universal in its application as the Stereoly, has certain advantages over the other. The separation of the two shots may be adjusted to suit any special requirements, a separation up to 6 inches being available for special effects. Any lens and any filter may be used for this type of work. The two resulting pictures are larger than those available with the Stereoly, but they cannot be viewed through the regular stereo viewing unit.

The Stereoly unit should not be used for photographing objects less than 5 to 7 feet from the camera. Close range photography introduces complications of parallax adjustment, since the optical axes of the two prisms of the Stereoly are theoretically parallel, intersecting one another at infinity. For this reason, photography of near objects may better be accomplished with the aid of the Stereo Slide Bar, into which the parallax adjustment may be introduced by careful manipulation.

Using Two Cameras

There is still another method of stereo photography feasible with the Leica camera, but for the present, it remains within the realm of experimental possibilities, there being a lack of specific accessories for the purpose. Such accessories would have to be produced by the experimentally minded worker, conceived by his own ingenuity and adapted to his specific requirements. This new method is mentioned here just as an experimental possibility for whatever it may be worth.

The method requires the use of two Leica cameras, each equipped with the same type of lens. It makes little differences which two lenses are chosen so long as they are identical. The experiment is available not only to those fortunate members of the Leica fraternity who own two cameras with lenses which are alike, but to any two friends who desire to pool their equipment, work and experience for the purpose of achieving interesting results.

The two cameras should be mounted together upon some rigid mount in such a manner that the bottoms touch, while the lenses face in the same direction. In order that the respective lenses be on the same level, it is necessary to have one of the cameras slightly higher than the other. With the cameras placed in this manner, operating controls on the outside are easily accessible. Such an arrangement is quite feasible since it so happens that, with the bottoms of the two cameras touching each other, the lenses are about 65mm apart. This provides the minimum separation. Greater distances may be secured by placing strips of cardboard between the bottoms of the cameras, or an accurately prepared wedge of wood, in the event that a parallax adjustment be required for special close range work.

Once these cameras are correctly assembled in a comparatively rigid unit, their operation is simple and effective. Such an outfit actually exceeds the Stereoly method in flexibility and adaptability for special work, such as close-up work, more particularly since it permits the use of interchangeable lenses, filters, and parallax adjustment.

Each of the two cameras should be equipped with the Universal View Finders, which also have the parallax adjustment, and exposures might be made simultaneously, either by hand or by means of cable releases. A truly de luxe method of operating the shutter releases would be provided by the Automatic Release, available for the synchronized operation of releases of the Micro Ibso Attachment, employed in photomicrography.

This method has distinct advantages over any other method of securing stereo pictures and should be considered seriously by all desiring to obtain stereos of a scientific nature. One of its potential advantages is the ease with which the parallax adjustment may be made, an adjustment decidedly essential for the correct viewing of small objects photographed at close range.

Depending on the focal length of the lenses employed in this work, the separate pictures will have some overlap, which will decrease with the increased focal length of the respective lenses. At all events, such overlap may easily be eliminated in making the prints or transparencies, either by means of masking them or trimming them just prior to mounting.

Making of Stereo Prints

Regardless of whether the Stereoly attachment or the Stereo Slide Bar, or the two-camera method has been used to make stereo negatives, paper prints may easily be produced from any of them. The prints may be of the contact type, but a much better job will be secured by making enlargements.

Enlargements or negatives produced with the Stereoly attachment are made on one sheet of paper, preferably of the glossy variety for greater brilliance and better detail. Before a print is made, the available stereo viewing equipment should be examined to determine the correct size of the finished print. It will be found to be most practical to enlarge the entire frame of the negative and trim it to the required size afterwards. Since there is no sharp line of demarcation between the two halves of the print, they should be cut in half carefully, or better still, left together unseparated, and thus mounted on a piece of cardboard of a size conveniently accommodated by the stereopticon.

In the case of two separate negatives obtained by the other two methods, separate enlargements will be made. It is important that both negatives be enlarged to identical size, with the enlarger in the same position, using the same paper, developer and exposures. Finished prints should be trimmed only after careful examination and tests made in the stereopticon. These prints should not be trimmed by a rule of thumb to include similar areas. It must be remembered that each picture has been secured from a different view point and there is a most decided difference in each print which has resulted in the three-dimensional aspect of a view. This point is mentioned to prevent arbitrary cropping of finished prints.

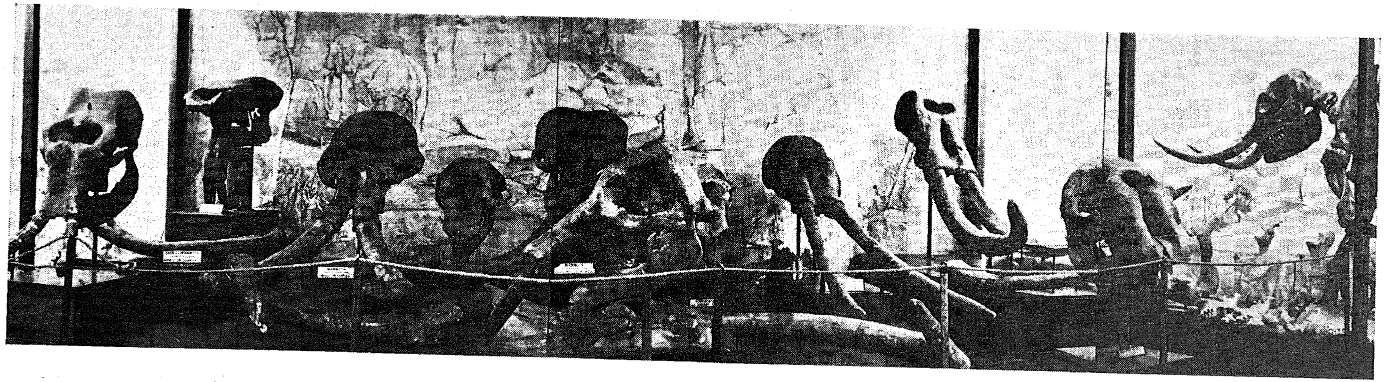


Fig. 172 Panorama View of Elephant Hall, Nebraska State Museum

Composite of three views

A. L. Lugn

PANORAMA PHOTOGRAPHY

A. L. LUGN, Ph. D. 	CHAPTER 13

Every amateur photographer has at one time or another come upon landscape scenes, interesting architectural settings, interiors of large buildings, groups of people and no doubt many other interesting photographic subjects which are beyond the limitations of the ordinary hand camera. Keen disappointment may have been experienced in an attempt to photograph these subjects from a distance sufficient to include the entire horizontal length of the scene within the long dimension of the average hand camera negative by use of the short-focus lens. When such a long picture is finished, the landscape is stretched across the print in a thin line with approximately ninety per cent of the print area a total waste. The details, also, are completely lost in their minuteness. At one time or another, every amateur has probably wished for a panorama camera which would combine the expanse of the view with the details of the scene.

The Leica camera, with its large negative capacity and its ability to take pictures in rapid succession has brought panorama photography within easy reach of the novice. Chance and guess work have been eliminated from the operation by the simplicity and dependability of the accessories required. Weighing but a few ounces, they consist of the following units:

1. **A Ball Jointed Tripod Head**—for leveling of the camera and for locking it in that position.
2. **Special Angle Bracket**—required for centering the lens over the pivotal point and for using the camera vertically.
3. **A Spirit Level**—fitting into the clip of the camera for horizontal pictures, or the clip of the Angle Bracket for vertical pictures.
4. **Cable Release**—serving to avoid jarring of camera and disturbing its position.
5. **Panorama Tripod Head**—with any of the interchangeable graduated rings, depending on lens used. Each of these rings has two sets of graduations: one for horizontal, the other for vertical use of the camera.

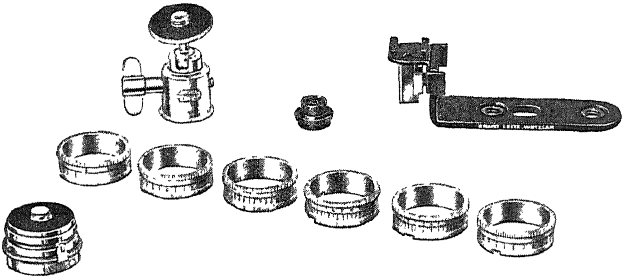


Fig. 173 Accessories for Panorama Photography:
Ball Jointed Tripod Head, Spirit Level, Angle Bracket and Panorama Tripod Head with interchangeable graduated rings for various lenses

6. **Universal View Finder**—if any but the 50mm lens is used.

Obviously, a good rigid tripod is essential for this work in order to permit the camera to be rotated around a pivotal point, for taking section views of a complete circle or of any portion of it.

Composing the Panorama

Photographs belong to two general classes: those intended as records of objects or incidents, and those whose purpose is to render a pictorial interpretation of things, people and incidents. Panorama photographs usually belong to the first classification, but they may, if desired, be used pictorially. Photomurals, for instance, frequently present opportunities of a strictly pictorial nature for panorama views.

In the case of record photographs, pictorial composition is not important and, therefore, a symmetrical picture is probably the simplest and most satisfactory. If a pictorial panorama is desired, the same principles of good design and composition which are employed in other forms of photography must apply. The chief difficulty will be found in maintaining unity. In a picture several times as wide as it is high, the eye covers too great space in one direction and is likely to fix upon many irrelevant details without being led to any particular center of interest. To avoid this and to permit the eye to travel smoothly from one end of the picture to another, the position from which the picture is taken should be carefully chosen.

Unimportant and undesirable details tending to distract from the main interest of the picture should be carefully eliminated. Where this is impossible, undesirable details may be dispensed with by means of paper negatives, enlarged negatives, obtained by reversal and such other means of control as are available for other photographic rendering. The most pleasing panoramas are those which do not cover

too great an arc of the circle, preferably no more than can be viewed from one position without turning the head.

Panorama Tricks

Certain kinds of tricks or stunts, possible with the Leica and panorama accessories, will readily suggest themselves to the reader. One or more persons or objects may be repeated several times in a panorama with a continuous background. Other effects may be accomplished with the camera attached to a universal tilting tripod head, by means of the angle bracket, in either horizontal or vertical position, making it possible to *panoram* vertically or at an angle. A tall tower or the details of a tall building may be photographed by *panoraming* at an angle, starting at the lower left and moving upward to the right. Interesting panoramas of tall buildings may be made in this way. This type of shot is best adapted to city scenes and should be very useful in some kinds of news or advertising illustrations. In making vertical *panoramas* of tall buildings, photographing them from anywhere but street level should be avoided as it will result in "bellying out" of the portion of the building nearest the camera level.

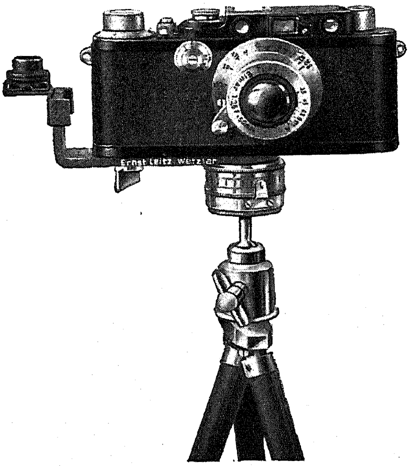


Fig. 174 Complete Panorama Outfit Assembled for Horizontal Pictures

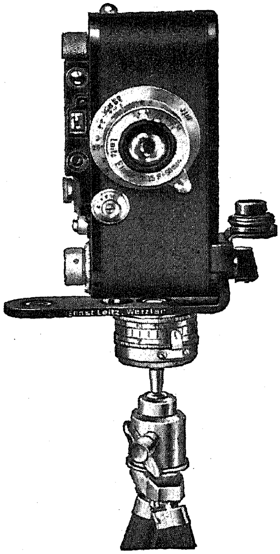


Fig. 175 Complete Panorama Outfit Assembled for Vertical Pictures

The nature of the subject, its size and relation to position of camera should determine the choice of the lens used. The short focus lenses, such as the 35mm or 50mm are best adapted to work in interiors where sufficient room for *backing* the camera is not available. The longer focus lenses may be used for distant outdoor scenes where it is necessary to *reach out* for details of mountain ranges, forests, glaciers, etc.

To take a series of negatives for panorama pictures, the first thing necessary is to select a suitable position for the camera. This will be determined by the nature of the subject, the purpose of the picture, available space, and composition desired, as outlined in previous paragraphs. The camera is set up on a sturdy tripod, attached by means of the panorama head and held either in the vertical or horizontal position. The former is to be preferred since it yields a higher picture with a somewhat better proportioned finished job. The camera should be perfectly level. If it is not, the sections, when trimmed, will *bow* up or down at the ends, resulting in a certain amount of distortion when cut to a rectangular shape.

The next step is to determine the farthest and the nearest points in the picture which are to be in sharp focus. To re-focus between the pictures of a panorama is impractical since this alters the relative size of the pictures and they will not match up. The lens stop, therefore, must be adjusted for the necessary depth of focus before the first picture is taken. The depth of focus scale (on every Leica lens) should be utilized for this. **The finished panorama is a series of separate** prints, joined so as to look like one large print. The negatives therefore should be absolutely uniform. In order to obtain such negatives, a dependable exposure-meter should be used and consulted before each separate exposure. It is important, too, that all exposures intended for one panorama be taken on the same roll of film to assure identical treatment in processing. Make sure that sufficient film is in the camera before starting to take a panorama; reloading the camera during a series of shots will most assuredly upset the job. After the exposures are made, the film should be processed and handled throughout in the same manner in which it would be handled for any other Leica photographic work.

At times uniform negatives cannot be obtained. Such may be the case in a large interior illuminated with artificial light. In such cases, the differences must be compensated for in the making of prints.

Making the Print

The technique of making prints for a panorama picture is not much different from that employed in making enlargements generally. The points of difference are: 1. Once the size of the final print has been decided upon and the enlarger set and focused, the latter should not be changed in any way until the last print of the series is made. 2. Areas of prints adjoining each other must match in tone values. This is achieved by maintaining a uniform temperature of developer throughout, using paper from the same package, giving the same exposure and development time, if the negatives are of uniform density. If they are not, it may be necessary to vary the exposures according to results obtained by means of test strips. A certain amount of *dodging or shading*—holding back or printing in, may be required for best results. It is advisable to make several prints of each section and to match the best ones for assembling the finished picture.

Assembling and Mounting the Finished Panorama

After the prints are made, they must next be matched, trimmed, and mounted. A suitable cardboard should be selected according to the photographer's tastes and desires, just as in mounting any other kind of print. Paste or dry mounting tissue may be used, but the writer has found dry mounting tissue to be the more satisfactory. Paste causes the prints to expand, not always uniformly, and they contract on drying. This almost invariably results in the prints pulling apart slightly, leaving a small but undesirable crack between the sections. This may be avoided with dry mounting tissue, and with careful manipulation, perfectly printed sections may be joined with scarcely a line showing. However, the most carefully mounted prints sometimes pull slightly apart in damp weather due to the expansion of the mounting board.

Since the trimmed edge of the paper is white, it is advisable to darken the edges with a pencil where dark areas of adjoining prints meet. If white or light-colored board is used for mounts, it should also be shaded with the pencil to match the print along all lines where prints meet. This is a small, but not unimportant, detail.

A sheet of dry mounting tissue is tacked to the back of every selected untrimmed print of the panorama. The overlap at the sides of each sectional print is carefully trimmed either on a sharp and truly square trimming board, or by means of a straight-edge and a knife or razor blade. When this is completed the details of adjoining sections are made to match. The prints are then placed on the table matched, ready to be put together. An accurate outline of the finished print is

then drawn lightly with pencil on the mount, squaring it up, if necessary with a straight edge or a T square. Each sectional print is fitted into its position on the mount, top and bottom receiving the final trim. They are then ready to be mounted.

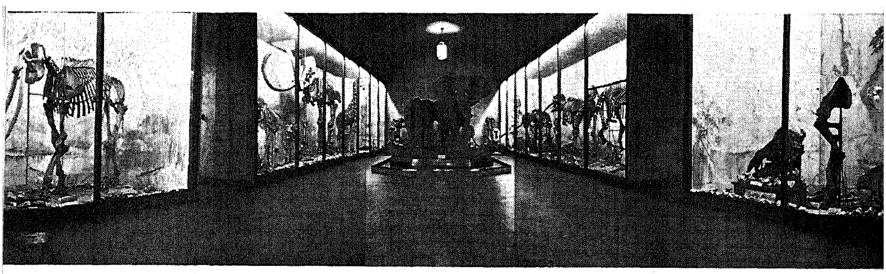
A pencil mark is made lightly on every sectional print and on the mount, indicating its final position on same. The edges of each print should be shaded with pencil at this point as well as the mount proper at points where two prints join. It is best to begin dry mounting the print by starting with the center section. The sections should be placed on the mount one at a time, lightly tacked with a tacking iron to the mount and then placed into the dry mounting press for about 15 to 30 seconds. If this is done carefully, no overlapping will take place. It is possible to use an electric iron for dry mounting, but the manipulation must be deft to avoid scorching and marks.

For permanence, and because of the amount of care and work involved in the making of such a print, it is best to frame it under glass on completion. If matt or semi-matt paper is used for the finished print, satisfactory preservation may be obtained by spraying the finished print and the entire mount with one or two coats of clear lacquer, which will protect it against dust and dirt. Thus protected, the print may be washed with a damp cloth if a good grade of lacquer has been used.

There are other ways of mounting prints, rubber cement or vegetable paste being quite as efficient, and frequently more convenient. Not many amateurs own a dry mounting press, and they may prefer these other methods, which are described elsewhere in this volume. (See chapter on Photomurals for mounting with vegetable paste, and chapter on Enlarging and Printing for mounting with rubber cement.)

Fig. 176 Hall of Elephants—Nebraska State Museum—A Panorama Leica Picture Made by Dr. A. L. Lugn

How the picture was made...50mm f:3.5 Elmar lens with diaphragm set at f:12.5, 2 minute exposures, DuPont Superior Film. Seven separate negatives used to make the complete panorama view.



NATURAL COLOR PHOTOGRAPHY

HENRY M. LESTER
ROWLAND S. POTTER

CHAPTER 14

A few months ago the Eastman Kodak Company placed at the disposal of Leica workers a new medium for direct Color Photography which eclipses most existing standards and results achievable heretofore in this exciting field. Luckily for Leica workers, the original designer of their camera selected the 35mm film for its negative material, and the new film is available at present in this size only. The new medium—KODACHROME FILM—was offered to Leica users after having been successfully used for over fifteen months in the field of 16mm cinephotography. Vast improvements made in the material proper, as well as in its processing, resulted in a film which leaves little more to be desired of it as far as emulsion speed, color rendering qualities and general flexibility are concerned.

As matters stand now, it is extremely simple to obtain one or a number of natural color transparencies; in fact, almost less difficult than to produce a good black and white negative. While subsequent production of color prints on paper is somewhat more complicated, it is nevertheless quite feasible through one of the two methods:

1. **The DEFENDER CHROMATONE.**
2. **The EASTMAN WASH-OFF RELIEF.**

By far the simplest part of Natural Color Photography is the making of color transparencies on Kodachrome film. Available in daylight loading magazines, ready to be inserted into the camera, in lengths sufficient for 18 exposures, Kodachrome need only be *exposed correctly,* sent to Eastman for processing (the cost of which is included in the original price of the roll), and it is returned in the form of excellent positive transparencies—sharp, grainless, free from color fringes, patterns or screens (shortcomings of some of the other color materials).

Kodachrome Film

Based upon the subtractive principle of color photography, Kodachrome reproduces natural colors as faithfully as seems possible at present. The separation of colors is secured in an unusual but extremely efficient manner: within the body of the emulsion itself. This is accomplished by coating the film support five times. These five layers consist of three coats of color sensitive emulsions, which are separated by two coats of plain gelatine.

Each of the three coatings of emulsion is selectively sensitized: that adjoining the film support is red sensitive; the center coating is green sensitive; and the outer, top, coat is sensitive to blue-violet. The two layers of plain gelatine prevent the sensitizers of emulsions from straying away from their respective coatings. The all-over thickness of these five layers is no more than that of the emulsion of ordinary black and white negative material.

When an image is focused upon Kodachrome film, some part of the picture is formed in each of these three layers, depending upon the color of the subject: red colored objects in the picture are recorded by the bottom, red-sensitive layer; green colored objects by the center, green-sensitive layer; and blue colored objects by the top, blue-violet sensitive layer. After the film is processed by the reversal method, each of the three coats of selectively sensitized emulsions is dyed with color complementary to its original sensitivity. The bottom, red-sensitive emulsion is dyed blue-green. The center, green-sensitive coat is dyed red (magenta). And the top, or blue-violet sensitive layer is dyed yellow.

During the processing the metallic silver image is dissolved and thus removed, leaving a pure dye image reproducing beautifully all colors of the original.

Two Types of Kodachrome

Because each of the three coatings of emulsion can be sensitized selectively, Kodachrome Film can be made for practically any purpose and of varying degrees of sensitivity in any of the spectral color regions. Accordingly, two types of Kodachrome Film are available to suit the two kinds of illumination: daylight and artificial light.

The Kodachrome Regular (K135) has an emulsion which is designed to produce correct color rendering in daylight without any filters or other accessories. However, a special Haze Filter will improve the results if used under certain conditions. Ultra-violet light which may occur in extremely distant scenes, snow scenes and at high altitudes, will record on the Kodachrome Film as violet. To correct this, the Kodachrome Haze Filter should be used (it requires no change in exposure). The same filter will also improve color rendering by imparting more warmth to the tones of scenes and people photographed on a gray day or in the shade.

Kodachrome Regular can be used in artificial light, provided a Kodachrome Filter for Photoflood (blue) is placed in front of the lens. This filter changes the quality of artificial light to that of daylight by reducing the excess of red prevailing in artificial light. There being a special type of film available for artificial light, the use of the Regular film should be restricted to daylight work. The filter generally has an exposure factor of 4x, which calls for too long exposures.

The Kodachrome Film Type A (K135A) has an emulsion especially corrected for use with artificial illumination so that no filter whatever is needed to obtain correct color rendering. Specifically, the color sensitivity of this film is very accurately adjusted for light of Photoflood and Photoflash bulbs. No other bulbs should be used if correct color rendering is desired. High-wattage tungsten bulbs are apt to make the pictures too red. The "daylight" or blue bulbs should not be used because they will make the pictures too blue. Similarly, arc lamps that produce light

approaching daylight in quality will make the pictures too blue on Type A Film. Primarily intended for work in artificial light, the Type A Film is not recommended for daylight, for which purpose it can, however, be used in connection with the special Type A Kodachrome Filter for Daylight, which is reddish-yellow to change the quality of daylight to artificial light by reducing the ultra-violet and the blue portion of its light.

Exposure

Every roll of Kodachrome Film is accompanied by very specific recommendations for exposures. The most satisfactory results will be secured by following these instructions to the letter. Color photography requires much more critically correct exposures than black-and-white work. Generally the latitude of color film is much more limited than that of black-and-white films (about 1/3). Such variables as climatic conditions, to which Kodachrome Film is rather sensitive, geographical latitude, accuracy of shutter speed and lens diaphragm, may tend to produce some over or under exposures. Until all such variables are fully under control it may be best to take three pictures of each scene: one exposure following the manufacturer's recommendation, one at twice, and one at half the recommended exposure. Intelligent and judicious use of a good exposure meter of the photo-electric variety should prove very valuable for getting consistently good results with Kodachrome Film. However, due to variations in color sensitivity of various meters, even those of the same make, they should be carefully checked and calibrated against actual results. The best way to calibrate one's meter is to make a few exposures strictly in accordance with manufacturer's recommendations, while at the same time securing a reading with one's own exposure meter. If both indications coincide and the resulting pictures are right the meter is correctly calibrated. Slight differences can be adjusted by resetting the emulsion speed from that recommended by the exposure meter to that corresponding to exposure setting which secured a well exposed picture.

For general guidance, subject to variations, it may be said that the Kodachrome Films can be rated as follows:

KODACHROME FILM:	Weston	Scheiner	Din
Regular K135 (daylight)	8	18°	11/10
" " (Photoflood light)*	3	14°	7/10
Type A. K135A (Photoflood light)	12	20°	13/10
" " (daylight)†	8	18°	11/10

* with the Kodachrome Filter for Photoflood.
† with the Type A Kodachrome Filter for Daylight.

Illumination

Color photography has its own requirements of illumination which are quite different from those applying to black and white work. In the latter, the differentiation of form, lines and planes is produced by contrasts of brightness and shadows cast. In color work much less contrasty illumination is required because the "tones" and gradation are produced by color. In outdoor work best results are obtained with the sun approximately behind the camera. It should be remembered that increased exposures are required if the sun is to one side of the camera, (almost double), and still longer exposures when the camera is facing the sun (about four times normal).

For indoor work with Photofloods a flat "flood" type illumination should be provided to avoid shadows as much as possible. Assuming that lights are being placed on both sides of the camera, most pleasing results will be secured when some 60% of the entire amount of light will come from one side, while about 40% from the other.

Several points should be remembered when arranging lights for indoor color photography. All Photofloods should be new. Each bulb should be used in a suitable reflector, the Kodaflector type or the Kodak Handy Reflector providing the least expensive and most efficient form. Each reflector should be directed upon the subject so that the full amount of light reaches it. When working in artificial light, daylight should be completely excluded; otherwise the pictures will show too much blue in those portions which were illuminated by daylight.

Instructions accompanying each roll of film contain a complete exposure table for use with Photoflash bulbs, which when followed to the letter with the aid of a tape measure will assure perfect results, where the use of Photoflashes is preferred to Photofloods, as in action shots, photography of children, pets, etc.

Viewing and Projection

Though a few photographers bemoan it, it seems particularly fortunate that the processing of Kodachrome Film is attended to by The Eastman Kodak Company. It must be remembered that the film consists of reversed images, there being no negative. Subsequent manipulations called for in the making of color enlargements require absolutely perfect transparencies, free from scratches, blemishes and any traces of handling. The Kodachrome transparencies as they arrive from the processing laboratory are very carefully packed and as a rule reach us in excellent condition. They should be immediately and permanently protected against any possible damage which may result if they are put in an enlarger, projector, or Stero Viewer. Depending upon the use to which they are put, they should be suitably mounted between glass. A number of mounts, masks and mats are available to meet adequately any possible requirements. The Kodachrome 35mm. transparencies can be mounted either in standard lantern slides (3¼″ x 4″) or Leica size lantern slides (2″ x 2″) or into strips of three exposures each for Stereo Viewing (bound between special cover glass measuring 35 x 120 mm, available through E. Leitz, Inc., New York). In addition to masks required for mounting between glass there are hand-viewing mats available in horizontal or vertical arrangement.

Under no circumstances should Kodachrome transparency strips be used directly in projectors or enlargers because scratches and abrasive marks, impossible to prevent, will promptly ruin the usefulness of the valuable strip. At the moment of writing no color duplicates are possible. Black and white copies can be made on panchromatic negative material by contact printing. From such duplicate negatives subsequent black and white enlargements can easily be made.

Black and White Enlargements From Kodachrome

Black and white enlargements from Kodachrome transparencies can easily be secured by projection upon Eastman Kodak Direct Positive paper. This is a reversible material, very easy to handle and its only drawback is that the Direct Positive paper is somewhat slower than the usual projection papers. One can secure an inexpensive complete outfit for direct positive work either for sepia effects or for black and white effects by ordering same through any Kodak dealer. Enlargements up to 5 x 7 can easily be made but if 8 x 10 enlargements are wanted a photoflood bulb should be used in the enlarger. One should be tempted to make black and white enlargements from Kodachrome transparencies for they are free from grain and have excellent definition.

It should be remembered when making enlargements upon direct positive paper that the Kodachrome film must be placed in the enlarger with the emulsion away from the lens to assure that the image will not come out reversed from right to left.

The greatest enjoyment can be derived from natural color transparencies by viewing them in the form of brilliantly projected pictures. There is, however, a keen desire on the part of photographers to make color prints, a desire which can now be gratified. The making of prints from Kodachrome transparencies resolves itself into two main parts.

Three Color Separation Negatives

The most critical and difficult part of the procedure is the production of three negatives from the Kodachrome positive transparency, in such a manner that each of these negatives records details of one of the three basic colors as they were separated originally within the body of the emulsion of the Kodachrome Film. This is accomplished by projecting the Kodachrome positive transparency by means of an enlarger upon panchromatic negative material, first through a green filter, then through a red filter, and finally through a blue filter. These negatives are made by three separate exposures upon three separate panchromatic negatives of any desired size. The filters required for this are of the standard three-color separation filter set consisting of A filter (25) B filter (58) and C-5 filter (47).

The respective densities of these three negatives will have to be such as to produce good color balance later in the making of the paper print. To secure this balance two conditions should be met. The enlarger lens should be exceptionally well corrected for color. A Photoflood bulb should be used in the enlarger, or a blue filter (daylight)

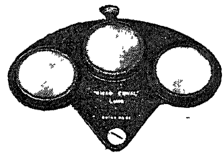
should be placed between the bulb and the lens of the enlarger. The exposure factors of the three filters used should be definitely established with regard to both light source of the enlarger and film used before exposures are made. Thus, for instance, if a film as Eastman Kodak Panatomic is used for making the negatives, the respective filter factors will be as follows: A Filter—3, B Filter—8, and C-5 Filter—12, if tungsten light is used. For other films, filter factors referring to artificial light offered on page 95 should be consulted, or obtained direct from the manufacturer whose film is used.

It should be remembered that the original Kodachrome transparency should be placed in the enlarger with the emulsion side facing away from the enlarger lens. This will assure correct placement of subject on finished color prints.

The negatives are then developed according to recommendations of the manufacturer to secure full detail and gradation. Each negative is carefully identified by a proper mark referring to the filter it was made with. The negative made through the red filter will then become the blue printer; that made through the green filter, the red printer; and the one made through the blue filter, the yellow printer.

Making Separation Negatives in the Camera

The Kodachrome film is undoubtedly the quickest and simplest method of obtaining the original color positive. Requiring no accessories "in the field" it can be broadly applied to action photography, and photography of living and moving objects. At times, however it may be desirable and possible to make three separate negatives of the same object. This is done simply by making three exposures on the same Panchromatic film, one exposure through each of the standard Wratten three color separation filters A, B and C-5. A set of these three filters mounted in a rotating segment is produced and distributed by the Chess United Co. of New York. This combination set is known as the "Trichromatic Separation Filter," is mounted directly over the lens and each of its three filters moved into taking position as required. (The same filter can also be used in connection with making three color separation negatives by projection in the enlarger.)



Trichromatic Separation Filter for use on Camera or Enlarger Lens.

The exposure factors of the three color separation filters vary depending on the negative material used. They will be found in the filter factor table on page 95. As a matter of convenience the following filter factors for DuPont Superior Film are given:

	Daylight	Photoflood	Mazda
A	9	5	4
B	5	6	6
C-5	6	10	13

It seems almost superfluous to point out that the camera must be rigidly supported for the making of three color separation negatives. A neutral density scale consisting of step gradations of white, grey and black, sharply outlined, should always be placed in a corner of the picture (so as not to appear later in the finished print but to appear on every negative). The scale must be illuminated in the same manner as the subject and should be sharply in focus to serve not only as a means of comparing the density of the negative but also as a means for registering the three prints in superimposing them. When the negatives are developed and dried they should be marked along the edge with good water proof India ink as follows: B for the negative taken through Red filter for blue color; R for the negative taken through green (to be colored red); Y for the negative taken through blue filter (to be colored yellow).

The color balance of the final prints will depend upon the care and relative correctness of exposure used in making the original black and white negative in the camera, or of the separations made from the Kodachrome positive. If correct exposure has been given the neutral density scale referred to will have the identical tone value in each negative. If the original negatives are not correctly exposed, it may some times be possible to make a slight compensation by varying the exposure during subsequent manipulations, but the results will not be as satisfactory as those originating from correctly balanced negatives.

The problem of securing proper balance of densities in the three-color separation negatives requires considerable experience before satisfactory

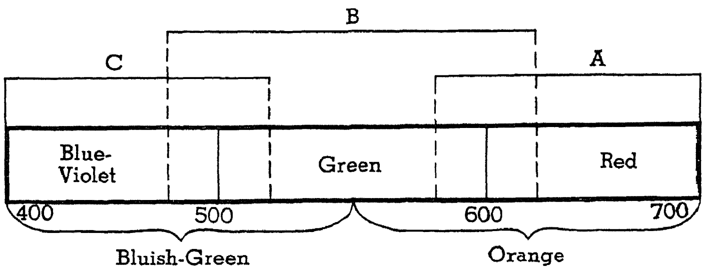
results are obtained and a good deal of experimental work will have to be done before the proper technique is acquired. However, once a set of satisfactory three-color separation negatives is available, one may proceed to make color prints by either of the two methods outlined below.

Defender Chromatone Process For Natural Color Photographic Prints

All manipulations involved in the Defender Chromatone Process are very simple, and little difficulty should be experienced by the Leica worker who is already familiar with the developing and toning technique. The process is based upon the principles of three-color photography of the subtractive type. Briefly, the process involves the superimposition of three transparent positive prints: one dyed yellow, another magenta, and the third blue-green—all mounted upon a white background, the finished product resulting in a picture in natural colors. The original photograph may be taken either by direct color film, such as Kodachrome or three separate negatives can be made by direct photography through green, red and blue filters. When the original color photograph has been made on Kodachrome, it will be necessary to make three color separation negatives as described above from which subsequently Chromatone color positives are made.

White light is a mixture of all known colors. White is not an absence of color, but on the contrary it is the sum total resulting from the presence of all colors. To show the presence of the components of light we can pass a beam of this white light through a glass prism with the result that the colors are separated into the spectrum: violet, blue, bluish-green, green, yellow, orange and red. Each of these spectral colors is a true color which cannot be broken down or separated into other colors by any known methods.

For practical purposes, the spectrum may be considered divided as shown in the following diagram:



The color of any object is due to the color of that portion of the incident light which is reflected from its surface. The other colors of the incident light that are not reflected are absorbed by the object.

It is commonly known that any color can be reproduced by mixing varying quantities of blue-violet, green and red colors. Therefore all three-color processes are based on photographing separately the primary colors: red, green and blue. In the case of Kodachrome this is accomplished within the body of one composite emulsion while in three color separation negatives made in the camera, or by projection, this is done by three separate exposures made through red, green and blue light filters respectively.

Making the Actual Color Prints

The principle of color prints is based upon considering the white paper stock upon which the print is being built up as the light source. This white paper stock reflects all colors of the spectrum. From each of the three separation negatives secured either directly through the camera, or by projection from a color transparency like the Kodachrome, positive prints are made upon a special stripping film (Chromatone Print paper) which is exposed and handled similarly to projection paper. The collodion emulsions of the Chromatone Print Paper are stripped off their base, toned to the proper color, which is complementary to the color of the filter through which its respective negative had been made, and superimposed over each other upon the white paper backing. The complementary color of red is blue-green; it transmits both blue and green, absorbing red, being therefore *white minus red.* The complementary color of green is blue red or magenta; it transmits both the blue and red, and is therefore *white minus green.* The complementary color of blue is red, green or yellow; it transmits both red and green, and is *white minus blue.* When all color prints are superimposed upon the white mounting paper, each print will thus subtract from the white of the paper all the portions of the original which were not blue, green or red, according to the respective light filters through which its negatives were taken. Such superimposed prints if correctly registered will give a print in natural color.

The black and white Chromatone prints are thoroughly fixed and washed for at least 15 minutes in running water. In the fixing bath the gelatin emulsion can be stripped or separated from the paper backing. The stripped emulsions should be handled with reasonable care to avoid formation of kinks. The next step is to tone each film in its respective Chromatone toning solution.

Toning the Separation Positive

The stripped off black and white positive films which are intended for the Red and Blue images are placed together in one tray and the Red and Blue toner-A made up according to the formula sheet accompanying the materials is poured over. They should remain in the A solution for at least 15 minutes thoroughly agitated until all of the black silver is removed. When these prints are thoroughly toned they will appear as a light greenish blue image. They are then placed in running water and thoroughly washed for about 10 minutes. It is essential that hands be kept clean at all times to avoid contamination of various solutions.

After this washing, the film to be toned is placed in the Red toner B, and allowed to tone for about 10 minutes. The solution is then poured off for use a second time, and the print is immersed for three minutes in a 15% hypo solution (granular or rice hypo: 2¼ oz. (70 grams)—distilled water 32 oz.—(1000 cc.) (Do not use acid fixing hypo). It is then washed for about 15 minutes in running water.

Similarly, the film to be toned Blue-green is placed in the Blue toner B and allowed to remain for about 10 minutes, after which the toner is poured off for use a second time, and the print immersed in a tray of weak hydrochloric acid solution for about one minute. Use one part of diluted solution hydrochloric acid CP: 16 oz. (500 cc.)—distilled water 48 oz. (1500 cc) with one part of water. The print is then thoroughly washed in running water for about 10 minutes after which it is placed in a tray containing standard hypo solution (see above) until greenish tones have changed to blue. It is then washed for 20 minutes in running water.

The Yellow toning solution (Yellow Toner A) is supplied in two solutions, equal parts of which are mixed for one. The print to be toned yellow is immersed in this solution for about 15 minutes. This work may be carried on simultaneously with the blue and red toning operations, separate trays being used. At the end of about 15 minutes the solution is poured off into a graduate and 10 cc (3 drams) of standard hypo solution is added to every 50 cc (2 oz.) of working solution, and thoroughly mixed. Next wash the print for 2 or 3 minutes in running water, or in one complete change of water, return it to the tray and pour the solution back on the print. This operation should be done quickly, and the tray should be vigorously rocked for about 1 minute to prevent

any streaking of the yellow image. The print is now allowed to remain in the solution for about 3 minutes, after which the solution is discarded, the print washed for a minute or two in clear water, and then immersed for about 1 minute in a solution made up of standard hypo solution—one part, water three parts. Do not keep the print longer than one minute in this solution as the image at this stage is slightly soluble in hypo and highlight detail may be lost thereby. Wash the film immediately for not less than 20 minutes in running water. The yellow image, after thorough washing, is immersed for about 2 minutes in the Yellow toner B, and then washed in running water for about 20 minutes. It is then ready for assembling.

The three-color images are now registered on a gelatin coated paper (Chromatone Backing Paper) which has been previously soaked thoroughly in water. Lay the backing paper gelatin side up, on a clean ferrotype tin, clean glass or Masonite tempered hard board, or on any flat waterproof surface. The Yellow image is placed first on the paper and squeegeed firmly into place, emulsion side down, and allowed to remain for a few minutes. The Red image is then placed on top of the Yellow, pushed carefully into register, squeegeed lightly, the register checked, and adjusted if necessary, and the Red image squeegeed firmly into place. If at this point the two images do not appear exactly in register, the Red sheet may be peeled off carefully, re-moistened and registered again. It will be found easier to register the Red and Yellow images if they are viewed through a light blue filter.

The Blue image is then superimposed upon the other two, precisely as described above, completing the color print; all prints emulsion side down.

The print is now allowed to remain in the air for about 10 minutes until the surface dries to some extent. Next, the damp print should be trimmed so that the edges of the collodion layers are flush. It is then placed on a piece of rigid, hard waterproof material. Masonite Tempered Hard Board is admirably suited for this purpose.

Ordinary Kraft gummed tape is moistened and the damp print fastened to the board with this tape overlapping the print about 3/16″ on all four edges. Do not have the gummed tape too wet or the gum will ooze between the print and the board, making it difficult to remove the print.

The print will dry rapidly, stretched absolutely flat. It can be loosened from the board when dry by carefully inserting a sharp knife through the tape under the edge of the print and running it around the print.

Chromatone prints, ordinarily processed, dry with a high gloss and great color brilliancy, which is considered desirable for illustrative and commercial work.

A MATT finish can be obtained by rubbing over the glossy surface with fine dry pumice powder. If the finished print is given a coat of good matt lacquer applied with an air brush, varying degrees of matt finish can be secured.

To obtain rougher surfaces, any of the regular rough textured papers, such as Defender Veltura Q, can be used instead of the glossy base paper when assembling the print. Simply fix the paper, without exposure and thoroughly wash it.

A very interesting detailed description of the Defender Chromatone Process, its principles and practical application is offered in a booklet that should be secured from the Defender Photo Supply Co. of Rochester, N. Y.

The above described Chromatone Process of making color photographic prints is one in which color images are formed on three transparent media which are permanently superimposed upon paper, forming a print consisting of a number of layers.

Wash-off Relief Process

Another method, in which relief images are formed on transparent supports and dyed with water soluble dyes, and in which only dye images are transferred to paper, known as the Eastman Wash-Off Relief Process is offered to our readers. This comparatively new but thoroughly tried process is readily mastered.

The Process in Brief

For the Eastman Wash-Off Relief Process of printing in natural colors, three-color separation negatives are required. These are employed to make prints, by contact or enlargement onto Eastman Wash-Off Relief Film. In either method of printing, the exposure is made through the support of the relief film. Positive silver images are first

developed in the relief films, and are then bleached in a bichromate solution. This bleach renders the gelatine of the photographic emulsion insoluble in the regions of the silver image. Then, by washing in warm water, all of the soluble gelatin is removed, and relief images in hardened gelatin are left adhering to the supports. These are fixed in hypo and thoroughly washed. The three relief images are then dyed in the Eastman Three-Color Printing Dyes, A, B and C. The dyed positives may be superimposed in register to form a three-color transparency, or they may be used in the imbibition transfer process to make three-color prints on paper. To transfer the dyes to paper, each dyed positive is squeegeed in turn onto a wet paper bearing a mordanted gelatin coating. A natural-color print in transparent and stable dyes is thus produced.

The Negative

Three-color separation negatives are made directly from the subject (or from Kodachrome positive transparencies as described earlier) on Wratten & Wainwright Panchromatic Plates, Eastman Portrait Panchromatic Film, Eastman Super-Sensitive Panchromatic Film, Eastman Commercial Panchromatic Film, or Eastman Panatomic Film through Wratten Filters, A, B, and C5 (Nos. 25, 58 and 47 respectively).

The negatives should be exposed with due regard for the filter factors corresponding to the light source employed, and all of the plates or films must be uniformly developed. The inclusion in the subject of a scale of greys near an edge of the field assists greatly in obtaining correct exposure and development of the negatives, or in making suitable adjustments in the printing in case slight errors of density or contrast are found in the negatives. If the set is correctly exposed and developed, any given step on a scale of greys should have the same density in each of the three negatives. The contrast or "gamma" for the scale of greys is preferable 0.8 to 1.2.

Step-by-Step Procedure of the Printing Process

Making the Relief Positives

1. Print by contact or projection through Wratten Filter No. 35 onto three Eastman Wash-Off Relief Films, exposing through relief-film supports.
2. Develop 5 minutes in Formula D-11 at 65°F. (18°C.).
3. Wash 10 minutes in running water at not more than 70°F. (21°C.).
4. Bleach completely (about 2 minutes) in Solution R-10 at 65°F. (18°C.).
5. Develop 4 minutes in water at 110°F. (43°C.).
6. Fix 1 minute in Bath F-24.
7. Wash 5 minutes in running water.
8. (Optional) Bleach brown stain by bathing 1 minute in Permanganate Reducer R-2.
9. (Optional) Wash 3 minutes in running water.
10. (Optional) Clear by replacing in Bath F-24 for 1 minute.
11. (Optional) Wash 5 minutes in running water.
12. (Optional) Dry.

Dyeing the Reliefs.

13. Dye reliefs in solutions of Dyes A, B and C for 30 minutes.
14. Rinse in dilute acetic acid of concentrations given.
15. Superimpose dyed reliefs for inspection.
16. If necessary, give corrective treatment.

Finishing Transparencies.

17. Dry Films.
18. Varnish, if desired, and dry.
19. Register films in superposition.
20. Bind films between cover glasses.

Making Imbibition Transfers to Paper.

21. Prepare paper in advance, or during dyeing of reliefs.
22. Transfer magenta dye.
23. Transfer blue-green dye.
24. Transfer yellow dye.
25. Dry print between blotters or on ferrotype tin.

FORMULAS

Dissolve all chemicals in the order given.

Developer (D-11)

	Avoirdupois	Metric
Water (about 125°F.) (52° C.)	64 ounces	2.0 liters
Elon	60 grains	4.0 grams
Sodium Sulphite, Desiccated	10 ounces	300.0 grams
Hydroquinone	1 ounce 85 grains	36.0 grams
Sodium Carbonate, Desiccated	3 ounces 145 grains	100.0 grams
Potassium Bromide	290 grains	20.0 grams
Water to make	1 gallon	4.0 liters

Use without dilution.

Wash-Off Relief Bleaching Solution (R-10)

Stock Solution A

	Avoirdupois	Metric
Water	16 ounces	500.0 cc.
Ammonium Bichromate	290 grains	20.0 grams
Sulphuric Acid C.P.	3½ drams	14.0 cc.
Water to make	32 ounces	1.0 liter

Stock Solution B

Sodium Chloride (table salt)	1½ ounces	45.0 grams
Water to make	32 ounces	1.0 liter

For use, take 1 part of *A*, 1 part of *B*, and 10 parts of water.

Non-Hardening Fixing Bath (F-24)

	Avoirdupois	Metric
Water (about 125° F.) (52° C.)	16 ounces	500.0 cc.
Hypo	8 ounces	240.0 grams
Sodium Sulphite, Desiccated	145 grains	10.0 grams
Sodium Bisulphite	365 grains	25.0 grams
Water to make	32 ounces	1.0 liter

Permanganate Reducer (R-2)

Stock Solution A

	Avoirdupois	Metric
Water	32 ounces	1.0 liter
Potassium Permanganate	1¾ ounces	52.5 grams

Stock Solution B

Water	32 ounces	1.0 liter
Sulphuric Acid, C.P.	1 fluid ounce	32.0 cc.

For use, take 1 part of stock solution *A*, 2 parts of stock solution *B*, and 64 parts of water.

Important: When preparing stock solution *B*, always add the acid slowly to the water while stirring the water rapidly. *Never add the water to the acid,* or the solution may boil over and spatter on the hands or face, causing serious burns.

Chromium Intensifier (IN-4)

Stock Solution

	Avoirdupois	Metric
Potassium Bichromate	3 ounces	90.0 grams
Hydrochloric Acid C.P.	2 fluid ounces	64.0 cc.
Water to make	32 ounces	1.0 liter

For use, take 1 part of stock solution to 10 parts of water. Bleach thoroughly, then wash for five minutes and redevelop fully (5 to 10 minutes) in artificial light or daylight in any quick-acting, non-staining developer containing the normal proportion of bromide, such as Formula D-11, diluted 1:3. Then wash thoroughly and dry. Greater intensification can be obtained by repeating the process. The degree of intensification can be controlled by varying the time of redevelopment.

Table of Dilutions of Acetic Acid

Concentration in %	Amount of Acetic Acid: Glacial Acetic Acid	28% Commercial Acetic Acid
1/10%	1 cc. diluted to 1 liter, or ¼ fluid dram diluted to 32 ounces	3.6 cc. diluted to 1 liter, or 1 fluid dram diluted to 32 ounces
½%	5 cc. diluted to 1 liter, or 1¼ fluid drams diluted to 32 ounces	18 cc. diluted to 1 liter, or 5 fluid drams diluted to 32 ounces
5%	50 cc. diluted to 1 liter, or 13 fluid drams diluted to 32 ounces	180 cc. diluted to 1 liter, or 5¾ fluid ounces diluted to 32 ounces

Aluminum Sulphate Solution for Mordanting Paper (M-1)

	Avoirdupois	Metric
(A) Aluminum Sulphate	6¾ ounces	200 grams
Water to make	32 ounces	1 liter
(B) Sodium Carbonate, ..Desiccated	1 ounce 145 grains	40 grams
Water to make	16 ounces	500 cc.

Add *B* slowly to *A*, stirring well during the addition. A white precipitate is at first formed, but this dissolves upon stirring. If a trace should remain, it can be filtered out with a rapid filter paper.

5% Sodium Acetate Solution

Dissolve Sodium Acetate. Anhydrous (E. K. Co.), 50 grams in 950 cc. water, or dissolve Sodium Acetate, Anhydrous 1-2/3 ounces in 32 ounces of water.

1% Ammonia Solution

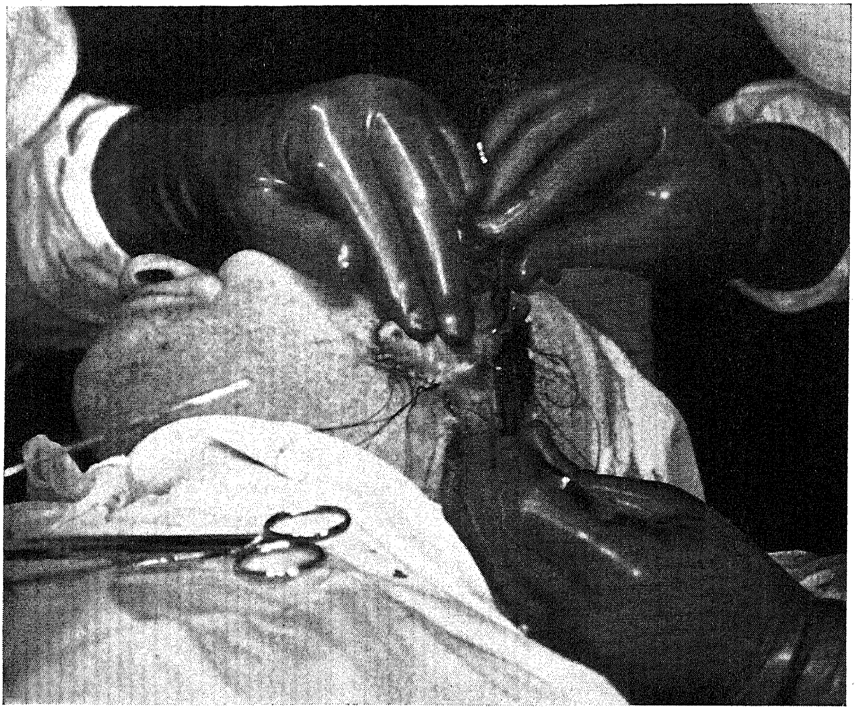
Add one part by volume of strong ammonia water to 100 parts of water.

Varnish Formula for Color-Film Transparencies (V-1)

	Avoirdupois	Metric
Gum Sandarac	365 grains	25 grams
N-Butyl Alcohol	6½ fluid ounces	200 cc.
Castor Oil	1¼ fluid drams	5 cc.
Oil of Lavender	¼ fluid dram	1 cc.

Warm the gum sandarac and butyl alcohol together until the sandarac has been entirely dissolved. *(Caution: Butyl alcohol is inflammable, and should not be heated over an open flame.)* Then filter the solution through a fine, lintless cloth, add the castor oil and the oil of lavender, mix thoroughly, and cool before using. The oil of lavender may be omitted if the odor of the castor oil is not objectionable.

The Eastman Wash-Off Relief process is essentially very simple, once understood and acquired. However detailed instructions and specific information covering every step of the procedure are absolute prerequisites of success in making color prints by this method. Accordingly the editors feel that they are performing an important duty towards their readers in briefly presenting the outline of the process. It is suggested that those seriously interested address the Graphic Arts Department of the Eastman Kodak Co., Rochester, New York, requesting latest issue of pamphlet entitled "Color Printing with Eastman Wash-Off Relief Film". The Eastman Wash-Off Relief Process is being constantly improved and latest information should be secured from the Eastman Kodak Company.



Face Lift Operation Henry M. Lester

Fig. 182 Transportation J. D. McCauley

THE LEICA IN VISUAL INSTRUCTION

ELLSWORTH C. DENT

CHAPTER 15

The onetime formal and rather bitter educational procedure of the elementary and grammar school is giving way to the more interesting and profitable method of encouraging the pupil in self-activity. The pupil is placed in a situation where it is desirable to make comparisons, secure information, and calculate solutions to problems, thus developing a need for the use of letters, words, figures, and other symbols of thought. The term, *motivation,* is used to indicate this more effective training procedure.

Visual-sensory aids to instruction perform a definite function in this procedure. A simple picture, carefully chosen, may bring a series of voluntary oral discussions, written compositions and mathe-

matical calculations equivalent to many of the former fearful assignments of themes and sums. Objects, themselves, may be used even more effectively, but frequently it is impossible to have the real objects available. Representations of those objects are next in value, and the photograph is one of the most economical of all representations. The photograph, properly made or chosen, may be even better than the object, especially for group instruction. Teachers are realizing this and are beginning to develop series of pictures for class instruction, very much as they might select reference books, magazines and other aids.

Pupil-participation is exceedingly important as a motivating agency. If the pupil, even the unruly one, can be made to feel that his presence and cooperation are important in the scheme of things,

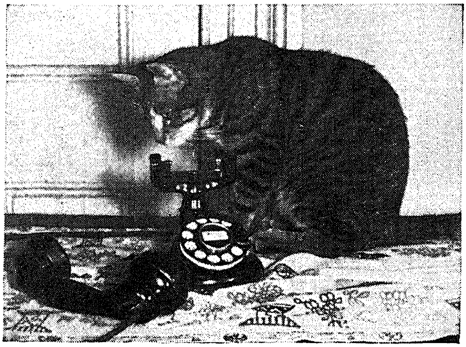


Fig. 183 This picture by Creighton Peet will gain the cooperation and interest of young Children very Quickly and Stimulate Conversation

life takes on a new meaning to him and education becomes something more than an endurance contest. Pupils may collect specimens, clip pictures from magazines and newspapers, build collections of hobbies, and do many things which will serve a dual purpose: (1) develop an intense working interest on the part of the pupil, and (2) develop a collection of materials which will be of inestimable value in teaching present and future groups.

One prominent visual instruction director *takes* pictures of his pupils in special situations. He secures a good picture of a pineapple field, for example. Next, he takes a picture of a member of the class in which the picture of the pineapple field is to be used. By clever photographic procedure, he combines the two to make a picture of that pupil in a pineapple field. The combined picture is transferred to a lantern slide for projection. The pupil is instructed in advance that he or she will be expected to tell, during the projection of the picture, just how it seems to be in a pineapple field. In order

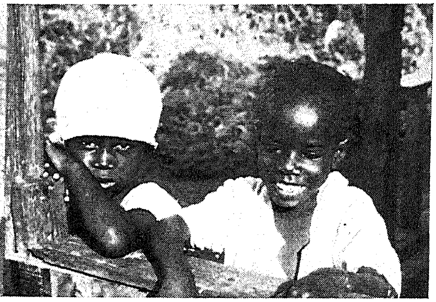



Fig. 184 Indian Children — Fig. 185 Negro Children

Pictures to show how the children of different races look, live, and play

to do this satisfactorily, that pupil must find out as much as possible about pineapples. Although photographic trickery is used to build a false situation, that situation proves to be a great motivating influence and increases the interest of the entire group in that subject. A similar procedure might be adapted to many situations.

Teachers are, properly, the most extensive travelers of any in professional work. Travel does much to broaden the outlook and increase the efficiency of the teacher. Some collect specimens of various kinds to be used later in teaching. Others gather pictures, pamphlets, curios, and the like, for the same purpose. But there is

Fig. 186 Harvesting in Siberia — Julien Bryan

Such a picture tells the story quicker and better than a thousand words

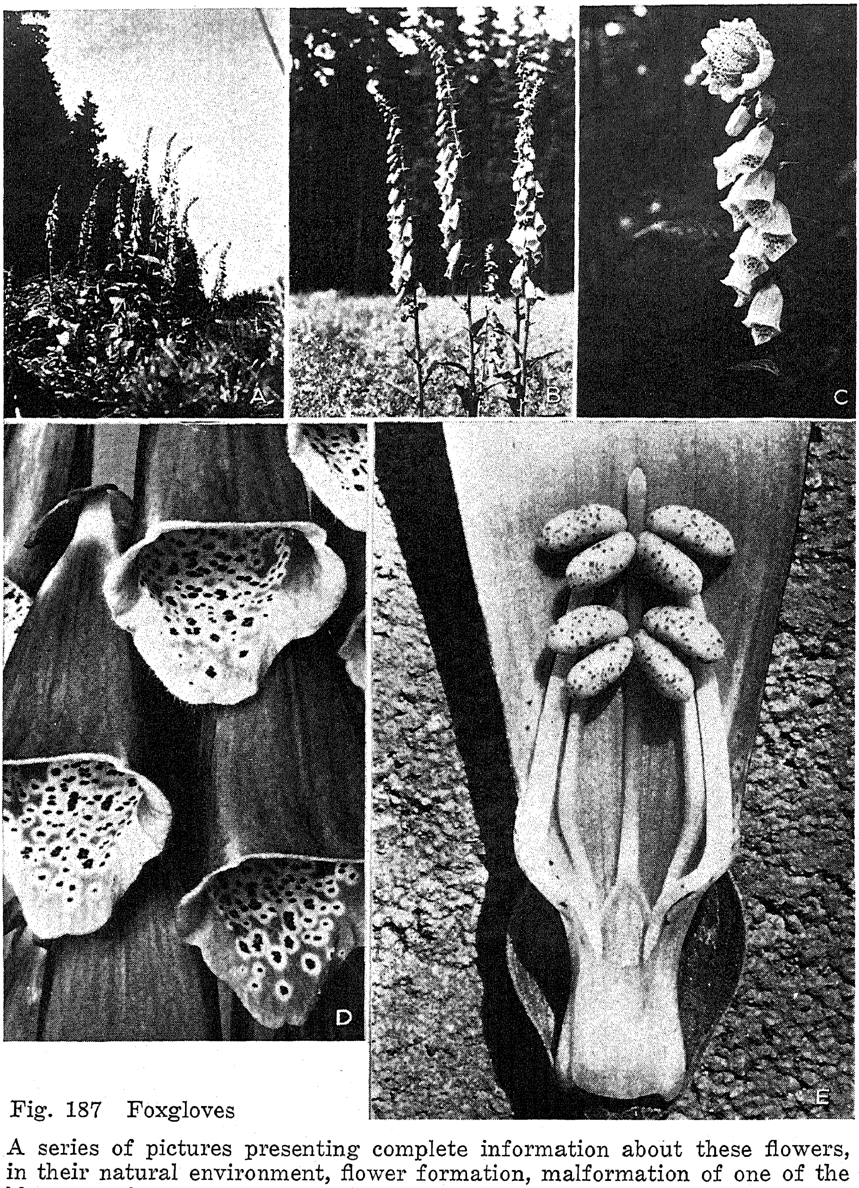


Fig. 187 Foxgloves

A series of pictures presenting complete information about these flowers, in their natural environment, flower formation, malformation of one of the blooms, and even a close-up cross section

an increasing number of those who are depending upon the camera to record the experiences of travel which may aid in the classroom.

All forms of plant and animal life undergo important changes during the summer months. Some forms complete their life cycles

during the period when pupils are on vacation from formal instruction. Things are happening which the child may not notice or may not understand. The brilliant colors of midsummer are gone when the importance and functions of color among living things are discussed in the classroom sometime between September and June. A camera which will record the changes, including accurate reproduction of color, and will make them available for later use in the classroom becomes one of the most valuable assistants any teacher could choose. The camera which would be satisfactory for this type of photography might be used equally well to record any other things

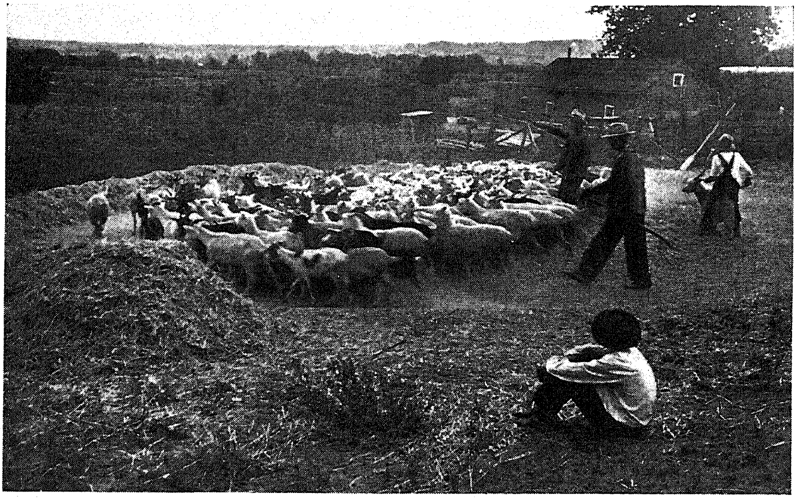


Fig. 188 Threshing in New Mexico Willard D. Morgan
In the little town of Chimayo, north of Santa Fe, this interesting threshing scene was photographed

of interest, including pictures of people, buildings, landmarks, points of historical interest, rock formations, trees, animals, and the like.

Inasmuch as teachers are not endowed, normally, with unlimited funds for such activities, it is necessary that photographic equipment be selected which will accommodate almost any photographic task and do it inexpensively. The Leica camera is meeting such requirements and is becoming increasingly popular among those who realize the potential value of pictures in teaching.

Educational Use of Pictures

It seems proper, at this point in the discussion, to mention some of the things to be observed in selecting or making pictures to be used as visual aids. In the first place, the mere showing of a picture

to a pupil or to a class may be an absolute waste of time except as it may inject variety into an otherwise dull classroom situation. An intelligent teacher would not inject the study of Chaucer into a class in the lower grades. Neither would that teacher assign problems in physics to a class in elementary mathematics. It is fully as important to select the proper type of picture for use in any given situation. The few simple suggestions noted below might well be observed in outlining plans for the selection and use of pictures in the classroom:

1. Pictures selected for educational use should be within the age, or grade-level of the pupils with whom the pictures are to be used. (A picture of the Parthenon would mean little to an elementary group and a picture of Mary Jane's doll house would not be appreciated by pupils in the upper grades.)
2. A few pictures which are pertinent to the subject under discussion would be preferable to many. The use of too many pictures is more likely and more harmful than the use of too few.
3. The pictures used should relate directly to the lesson or unit of instruction and should contain few or no irrelevant details. Anything which may not so relate to the subject under discussion will have a tendency to detract seriously.
4. Each picture should contain some object of familiar size. A person, an article of clothing, a pencil, or any other object commonly known to pupils will aid in conveying a correct impression of the primary subject of the picture.
5. Pictures should indicate action whenever action will aid in presenting a natural situation. Animals moving about, children at play, farmers at work in their fields, make excellent photographs and are vastly more interesting than *posed* pictures.
6. Pictures must be mechanically correct and of sufficient size to be viewed without eye strain. This applies particularly to projected pictures but might be applied as appropriately to photographs and enlargements.

There are many sources from which organized picture units may be secured. Some are for sale and some may be borrowed. The school which is able to purchase an adequate supply of pictorial materials for use among its teachers places those teachers in a fortunate situation. However, if it should be possible for each school to purchase a liberal supply of available pictures, there would still remain many occasions for the use of a camera to record special activities and scenes of local importance or for special application to teaching problems. Inasmuch as no school is able to purchase all desirable material and many schools are able to purchase little or none, a suitable camera becomes highly important to those teachers who desire to present instructional material in an interesting and effective manner.

The Leica Camera

The cost of producing suitable pictures for school use has been a hindrance to the wider use of appropriate illustrations. The average camera will produce a reasonably good picture under ordinary

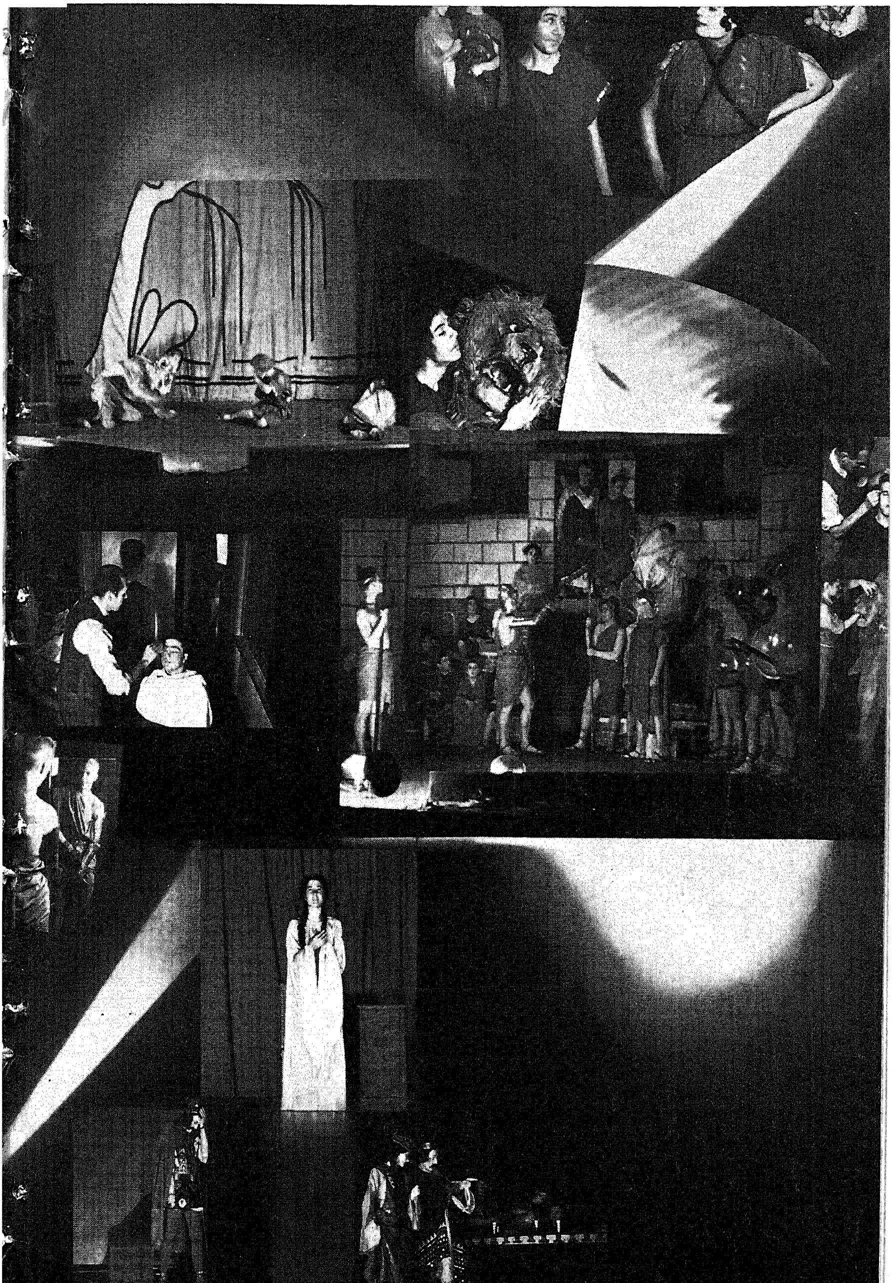
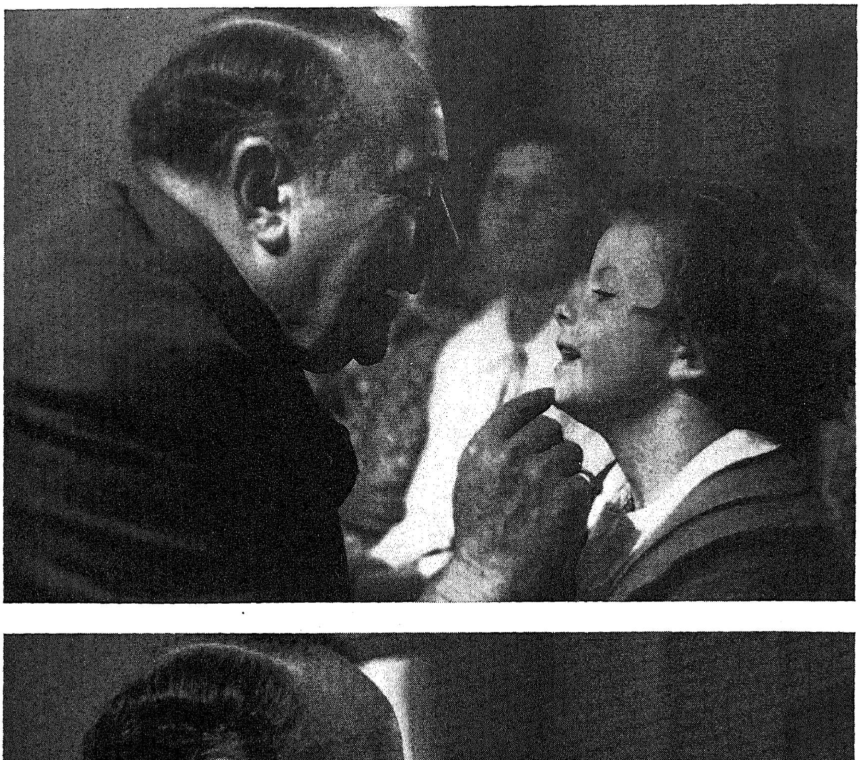


Fig. 189 Dramatics Montage Designed by Barbara Morgan

From 1936 Pean, school annual, Phillips Exeter Academy, New Hampshire. The individual shots are from the productions of "Macbeth and Androcles and the Lion" and were photographed by students of Phillips Exeter Academy.



Teaching the Deaf to Speak — J. Winton Lemen

Summar 50mm lens, f:2.2, 1/3, E. K. Super X film.

conditions but that picture is not ready for use in the classroom. It is too small to be clear in all its details and it is not in proper form for easy enlargement through projection. If enlarged as a photograph, the cost is prohibitive, and it must be transferred to glass or film for suitable projection. The latter procedure requires special apparatus and materials, involving considerable expense.

The Leica camera, on the other hand, is capable of producing film strips for projection at a ridiculously low figure. The teacher who will follow a few simple directions can prepare such pictures at a cost which will range from four to six cents per picture using inexpensive apparatus for developing and printing. Furthermore, this same camera may be used to copy large or small pictures for similar projection. The Leica camera will photograph anything from very small miscroscopic organisms to the largest things in the known world. The chapters on Copying and the making of positives give more complete information.

If it should seem desirable to use photographs of any convenient size, or of various sizes, such enlargements may be made by using enlarging apparatus which is both inexpensive and simple to operate. Refer to the chapter on Enlarging. The cost of such enlargements will be very little more than the cost of the negative for the average camera and the enlargements may be made to conform to any desired size or type. The negatives may be filed in small space, cataloged, and used for reference purposes as needed.

If it should be desirable to make and color lantern slides of any or all of the negatives, the procedure is more economical than the production of slides by any other method, and the results are highly satisfactory. For ordinary classroom purposes, the double-frame film slide produced by contact printing of Leica negatives will be almost as satisfactory as the glass slide and will be much less expensive.

Some teachers find that their regular duties require so much time that it is impractical to use the small amount of time required to develop and print or enlarge miniature pictures. In such cases the most logical solution of the problem is to organize a small camera club of older students who may be interested in photography. Such a club will serve many purposes. It will train its members to apply leisure time in an interesting and profitable activity. It will develop a greater interest in the production and use of pictures throughout the school. It will build a useful and valuable collection of pictorial materials at low cost to the school.

Convenience is another attribute of the miniature camera which should be given careful consideration. It may be carried in a handbag, in the pocket, or suspended on a small strap. It is always ready for action and may be adjusted to any special situation quickly. It is simple to operate and all necessary adjustments are made in less time than is required to mention it.

Fig. 190 Bark Splitting on a Five Year old Peach Tree from the low Temperatures of 1929-30. Note the Healing over of the Exposed Area

Photo by M. J. Dorsey

The adaptability of the miniature camera is the greatest of all. The various simple attachments which are available to adapt it to special situations cover every possible requirement. The wide range of available lenses will accommodate anything anyone could photograph with any other camera or group of cameras. In all this, the cost of operation is much less than would be the cost of operating the ordinary pocket camera which uses rolls of six to ten or twelve exposures.

The Miniature Camera in Special Subjects

Agriculture. One of the chief handicaps of the teacher of agriculture in the average school is that the principal crops grow, fertilize and mature during the months of the school vacation period. The animal life of the farm has undergone important changes. There are many printed reports of what has taken place and the teacher may be able to describe the developments in an interesting manner. However, a pictorial record of those changes could be made with the Leica camera and used to enliven the classroom discussions of various farm crops and animals.

The agriculture teacher who goes to fairs and other exhibitions of the best in farm products might not be able to bring samples of

those products before his classes for study. It would be rather simple to make a complete series of pictures of the most important ones. The cost would be but a few cents per picture and the possibilities would be unlimited. The convenience of small size makes it possible to carry the camera constantly for the purpose of photographing anything which might be of importance.

A further great advantage of the miniature camera is the ease with which it may be used to copy charts, graphs, drawings, prints, or other graphic materials for projection or reproduction. Frequently, valuable charts are accessible for study but may not be taken from library or private collections. In practically all such cases, permission to photograph those charts may be obtained. The photographs of the charts may be projected for study and are really more useful than the original charts in some instances. The miniature camera is ideal for such copying.

Biological Sciences. The possible uses of the Leica camera in preparing materials for use in teaching the biological sciences are unlimited. Photographs and photographic enlargements of specimens of all sizes, types and colors may be photographed and pro-

Fig. 191 A Parent Bird and Family. Photo by Charles A. Proctor

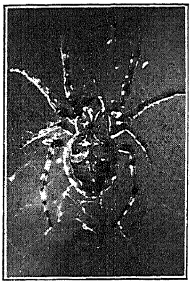


Fig. 192 (*left*) Cotton Blossom and Plant. This Picture and the two Above give a Quick Impression of the Subject by Eliminating all Unessential Details

jected or reproduced accurately. A series of photographs showing successive changes in living forms may be made at little expense. Flowers, birds, roots, leaves, seeds, insects, animals, and all usual types of microscopic cross-sections, plants and animalcules may be photographed with ease and accuracy. Teachers who conduct research during vacation periods or who may desire to produce special pictures for class use will be unable to secure a substitute for the miniature camera which will fill the requirements at such low expense.

Languages. Objects are becoming increasingly important in the building of a vocabulary. Projected pictures may be used in all classes, from the lowest elementary grades through the foreign lan-

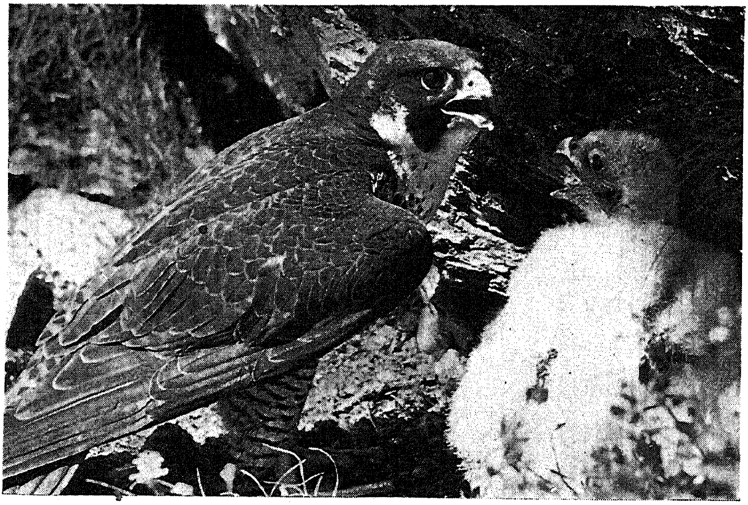


Fig. 193 Peregrine Falcons Charles A. Proctor

A mother and her youngster give the photographer a tough look

guage groups in colleges and universities, for the purpose of fixing new word symbols or clarifying the meaning of the old. The language teacher who has long desired a collection of representative pictures for use during the teaching of vocabulary may use the Leica camera to copy such pictures from books, magazines, travel bulletins, and the like. Furthermore, those who travel will be able to prepare adequate collections of original photographs at low cost.

A projected picture in the classroom is one of the most potent stimulators of oral expression and may be made the central topic for a major part or all of a recitation period. All such expression will but tend to develop greater facility in the use of words, regardless of the language employed.

Another profitable use of the Leica camera in language instruction would be for photographing and projecting charts of word

Fig. 194 The People of Tibet Harrison Forman

These pictures are full of details. Note man in the background holding his hands over his face...why? A market scene...ornaments...dress...superstitions

forms and endings, thus eliminating the tedious procedure of copying such material on blackboards or on charts. With a little camera, a little care, and a little energy, the energetic teacher will be able to increase the effectiveness of instruction with a saving in time to all concerned.

Geography. The myriad possible uses of the miniature camera for the preparation of materials to be used in teaching geography

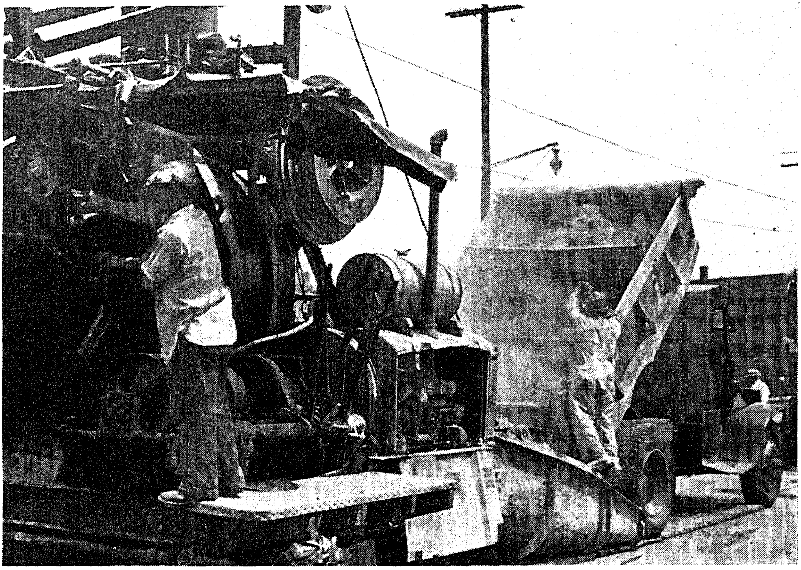


Fig. 195 The Concrete Mixer W. H. Friedrich

An excellent action picture which shows the mixer in actual operation with humans to give the scale and a more personal quality

stagger the imagination. Pictures of people at work and at play in all corners of the earth may be photographed by those fortunate enough to travel widely or may be copied from suitable photographs. These, projected in the classroom, are second in value to travel in giving true concepts of the way others live.

The same Leica camera may be used to copy detailed outline maps which may, in turn, be projected against a white cardboard or blackboard for study and for fixing locations. Pictures are exceedingly valuable in the study of human relations and the miniature camera offers the most economical means of providing those pictures.

Local geography is neglected frequently but could be utilized to good advantage. Those features which are difficult to observe by excursion or field trip may be photographed and brought into the classroom. The fact that such pictures are of local situations will tend to increase their value as related to the teaching problem.

History. Again, the teacher who travels may produce a series of pictures which would be of inestimable value in the classroom. It would not be necessary to travel widely. Local history forms an important part of the instruction in all schools and could be made a great motivating agency in both oral and written composition. Pictures of landmarks of early development, homes of famous per-

sons, federal and state governmental buildings, and of any number of other places could be obtained either by direct photography or by copying from publications of all kinds.

The Leica camera is so inconspicuous and convenient to use that many are able to collect excellent assortments of pictures of important figures in the events of the day. The possible use of such a camera to produce pictures for use in connection with the study of current events are many.

Industrial Arts. Here the Leica camera may be used to good advantage for the preparation of either elementary or advanced work. Certain master drawings might be photographed and projected on a screen for group study, a far more satisfactory method than to make a drawing large enough for the class to study, and incomparably better than passing an outline or a drawing from one student to another. Furthermore, materials thus organized for presentation could be preserved in small space and brought out for service as needed.

One instructor in engineering in a mid-western university uses a miniature camera to copy drawings and outlines of special problems and their solutions. Such problems are illustrated and discussed in the professional magazines and the former method of this instructor was to draw enlarged charts of ample size for the class to discuss

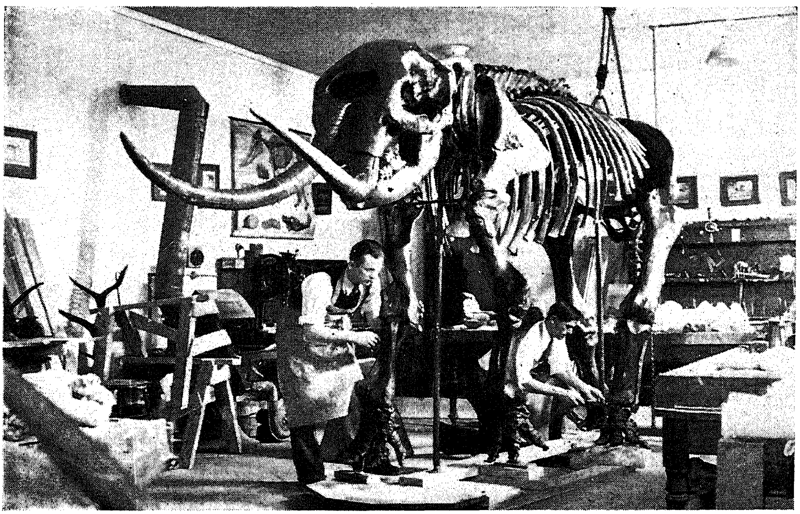
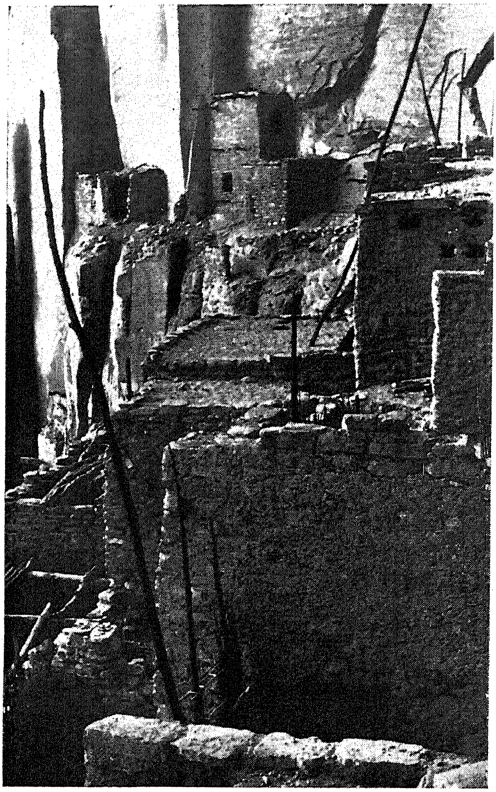


Fig. 196 How Are the Bones and Fragments of a Prehistoric Animal Assembled and Mounted? Photo by Dr. A. L. Lugn



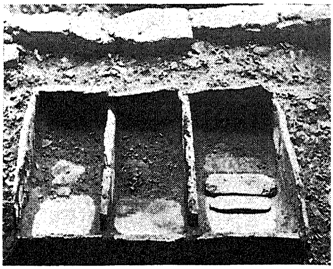


Fig. 197 Stones For Grinding Corn in an Arizona Cliff City

Fig. 198 Betatakin Cliff Dwelling in Arizona. A City once Inhabited by several Thousand Indians. Photos by Willard D. Morgan

as a group. Now, it is only necessary to photograph the page with the little camera, make a print on film, and project that print to any desired size. If charts seem desirable for use in the solution of similar problems, they may be made quickly by tracing the projection on suitable paper. The process is simple, rapid, and inexpensive. It would be almost as easy and but slightly more expensive to make photographic enlargements for such members of the class as might require them.

Architecture. This is the branch of engineering which is served best by the miniature camera. Many interesting photographs of desirable types of architecture may be made at little cost and studied at will. With one camera loading of 36 pictures it is possible to photograph exterior, and interior views of a building, and also make numerous close up detail views. This strip may be reproduced on a filmslide strip for projection at a cost varying from four to five cents per picture. The cost of making such pictures with the miniature camera is so little that various angles of each design may be recorded at less than the cost of a single picture of average camera size. Small designs in professional publications may be copied and enlarged to any desired size. So long as the resultant enlargements are

made for personal use and not offered for distribution, there is no infringement of copyrights or question of unprofessional ethics.

Physical Training. Many schools offer various forms of corrective gymnastics. Students who seem to require correction of physical defects or irregularities are photographed before the training is started. They are photographed during the process, until correction ends. The miniature camera, producing pictures with enlarging and projection possibilities, becomes the first choice of the physical training supervisors who give this record work serious thought.

The photographs of corrective changes are important but by no means exhaust the possible adaptations of the miniature camera to corrective or competitive athletics. The Leica camera is equipped with a lens and shutter competent to photograph all types of action, stopping that action at any point for careful study of form. In many instances, such stop-motion pictures are as valuable to the coach or trainer as would be motion pictures of the same athlete in action. These pictures may be used effectively to point out both good and bad points in the form of the athlete. The suggestions are vastly more clear to him than if made orally without some form of supporting illustration.

Doctors and dentists who are charged with the responsibility of medical and dental inspection of school pupils are finding the miniature camera

Fig. 199 Dentition. Child 6 to 7 Years Old. Primary Teeth Yielding to Pressure of Secondary Teeth. Photo by Henry M. Lester

to be of great value in photographing physical irregularities which need correction, such as poor teeth, enlarged joints, improper muscular development, eye defects, and the like. Peculiar situations may be photographed for more detailed study through enlargement or projection. It is possible, with this type of camera, to photograph the most minute structural details, even those which are recorded through the lens of a microscope.

Physical Sciences. Many photographs may be accumulated which will illustrate, clearly, the application of the simple laws of science to the

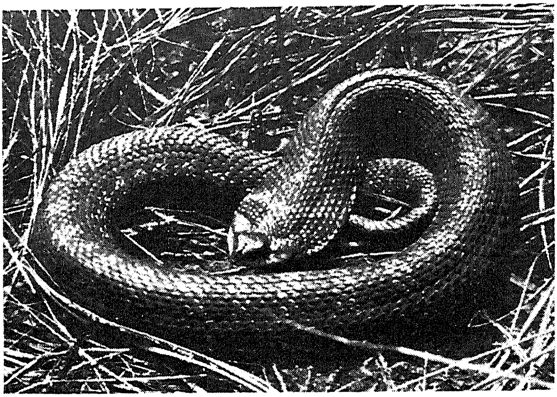


Fig. 200 Hog-Nosed Snake Photo by J. M. Leonard

rather complex structure known as civilization and its environment. Photographs of geologic formations; the work of water, wind and temperature as they change the surface of the earth; the effect of volcanic eruptions and of glacial action; and of the application of physical laws to the mechanical devices of industry, may be made quickly and cheaply.

Other Subjects. The suggestions made above are but a few of the possible applications of the miniature camera to visual instruction. The enterprising teacher or visual instruction director will find some use for such a camera in connection with the effective teaching of almost every subject listed in the curriculum. One of the great failings of textbooks for use in the elementary and intermediate grades is that they contain illustrations covering situations which are not within the understanding and personal experiences of the pupils. It is not difficult to supplement the textbook illustrations with local pictures of similar situations, thus developing a clear and logical understanding of the matters discussed in the text and during the class period.

The application of the miniature camera to the problems of classroom instruction by no means exhausts the possibilities of its use in the school building or system. For example, one very successful school administrator carries a minature camera wherever he goes among the various buildings to observe the work in the classrooms or to inspect the school plant. When he notices an unusually fine type of project, he photographs it. If some student has completed an outstanding piece of work, he makes a picture of it. If an alteration or a repair is needed in a school building or among its equipment, he may take several pictures of the situation. The resultant

pictures are prepared for projection before teachers' meetings, the board of education, the building committee, or before any others who may be interested in the work or welfare of the schools. These pictures become a permanent record of progress, frequently quite valuable in clarifying misimpressions among those who are not thoroughly informed concerning conditions.

The Leica camera is almost ideal for the production of pictures of school activities to be used for all types of publicity. Although the school annual is becoming less important to student life each year, there are local and school papers and periodicals which make good use of interesting pictures. Such pictures can be made with this camera at a cost of a few cents each. It is almost certain that many more good pictures will be available for such purposes than if the cost should be several times that amount.

The school which may desire to make the most effective use of pictures will find many uses for the miniature camera. Furthermore, the cost of operation will be but a fraction of the cost of usual types of picture making. The individual teacher or supervisor who may be interested in building collections of illustrative materials for classroom use will find the miniature camera to be an economical answer to the problem of covering unlimited demands with a limited budget.

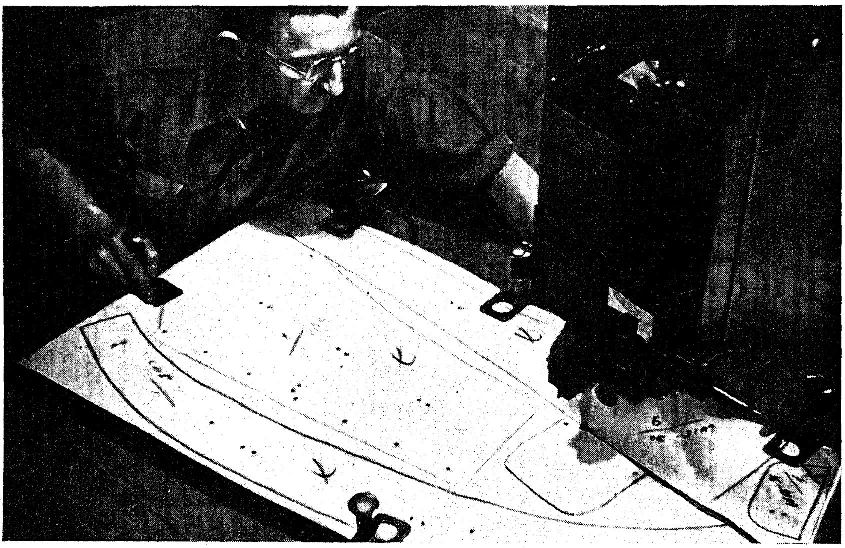
Fig. 201 Rock Structure, Segi Canyon, Arizona, Showing Horizontal and Vertical Structure. Photo by W. D. Morgan

Dress Patterns in the Making — Henry M. Lester

Drilling the Guide Perforations and Cutting a "Lay" of One Thousand Patterns

Summar 50mm lens, 1/60 second at f:2.2, Super-X Film

Courtesy of Butterick Company



THE LEICA IN HISTORICAL RESEARCH

JAMES A. BARNES, Ph. D. CHAPTER 16

Modern scholarship demands of the research worker of today impeccable evidence to substantiate his assertions. Such evidence can very rarely be presented in the form of originals of historical material. True copies are therefore required. These not only must be good and accurate reproductions; they must be obtained speedily and effectively. The Leica camera conveniently fulfills these requirements.

At one time the student spent the greater part of his day in laboriously copying his finds or discoveries. Materials of the most varied character—illegible letters, worn diaries, old faded newspapers, statistical tables, and intricate election returns—may be copied. These records can be secured photographically far more efficiently and in incomparably shorter time. Subsequent ability to enlarge to almost any size is an added advantage as it greatly contributes to the legibility of such records.

There can never be a question concerning the accuracy of reproduction; not only the form of the original is retained in such a copy but frequently even its spirit and intent.

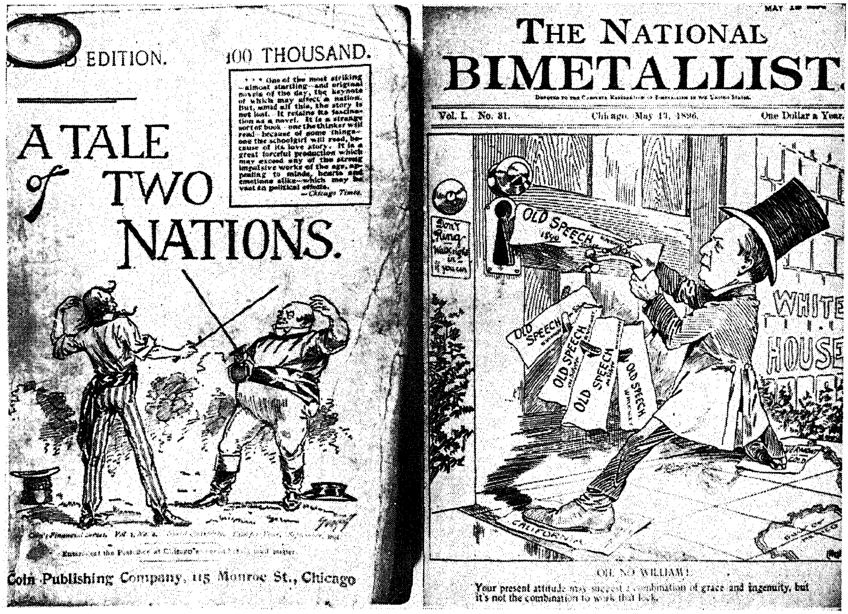
The research worker, when he comes to writing, need not, as he must when working from typed copies, wonder if the typist or the original writer made the strike-over, the omission, the abbreviation, the cancellation, the interpolation, or any of the peculiarities which mark all human documents. The genuineness of signatures and handwriting and even the character of the paper used may be easily authenticated. There can be no doubt as to whether a letter was handwritten, typed, or printed; that a letter was dictated and *signed in his absence* is easily discovered. Such apparently trivial but sometimes important points as whether the address given on a letter was merely a printed name or a part of the written manuscript itself are readily established. Quotations in the final copy for a book may be checked against the original document.

A very important asset in copying by camera is inclusiveness. An entire manuscript or document can usually be recorded as

cheaply and as quickly as it can be extracted. Seemingly insignificant sentences in a manuscript may take on, at a later date, a meaning not discerned at the time of copying. The mere fact that a letter contains no mention of a current event or existing condition may later prove of great value if one can be certain that the omission was committed by the writer and not the extractor. Adjacent paragraphs may give to a statement meanings or modifications not perceived at the time the research worker copied the document. By recording the entire original, the camera retains the proper setting of desired extracts.

The camera not only provides accuracy, speed, and inclusiveness in copy work; it enlarges the field of research. No longer must the scholar limit his labors to what seems at the moment important; as already mentioned, he may copy somewhat lavishly without adding perceptibly to the bulkiness of his material. Maps, charts, and graphs may be readily copied in whole or in part. By use of the extension tube the smallest section of a chart or graph may be lifted out of its original setting and enlarged for particular study. The cartoon, most pungent expression of contemporary opinion, may now

Fig. 203 Books, Manuscripts, Cartoons, and Similar Subjects can be Copied for Historical Research. Photos by James A. Barnes



make up an important and significant part of the files of the research worker who uses the camera. The writer's collection of several hundred cartoons, gathered from every section of the country at small reproduction expense, interpret the local attitude on economic and financial questions in the period of the eighties and nineties more poignantly, perhaps, than any other one possible type of source material.

Obtaining Complete Historical Record Pictures

But maps, charts, graphs, and cartoons do not complete the list of new sources made readily accessible. Highway signs, terrains, badges, handbills, broadsides, uniforms, machinery and implements, deserted villages, abandoned mining camps, relics, ancient, medieval, and modern inscriptions, and even flora and fauna, are readily and accurately recorded by Leica miniature photography. Whatever the eye can perceive as source material, the camera can record and preserve. My own files on *the great depression of 1929* may in future years prove richer because of their inclusion of photographs of silent factories, of bread lines, of the unfortunates seeking warmth and a place to rest in the St. Louis Public Library, of the bonus marchers, of men and boys tramping the highways and riding the transcontinental freights looking for work, and of many other evidences of economic turmoil. The *New Deal* may prove more interesting because of a photographic record of the inauguration, of closed banks, of farmers plowing under cotton, and of emergency workers on government payrolls.

There are other advantages. The research worker often finds the amount of time that he can spend at a given place limited. The camera prolongs his stay in effect by enabling him to accomplish more than he can by any other method of copying; it also permits him to bring exact reproductions of the original documents to the quiet of his own study for careful analysis and interpretation. This is particularly important where translation is necessary. The scholar who works in European archives on a summer's journey has not the time (and often not the money) to spend hours puzzling over a manuscript the chief difficulty of which is translation, when he may project the writing in an enlarged form on a wall or screen in his own home.

A university friend whose time for traveling was extremely limited recently photographed enough of the literature of the Pennsylvania Dutch in a few weeks to employ all his study hours for a year. Transcription too sometimes presents problems. The writer

discovered a particularly valuable diary in Kansas; unfortunately, it was written in a system of shorthand with which he was not familiar. Its value was attested by the convenient fact that many pages had been partially transcribed. The diary was photographed quickly and cheaply and later consultations with expert stenographers resulted in its complete transcription.

The Research Equipment

The entire camera outfit for traveling research is little bulkier than a typewriter. I recently completed a twelve-months research trip through the West and the South in which I collected more than twenty thousand copies of manuscripts. My equipment consisted of a Leica camera, Fuldy Copy Attachment, baseboard, upright and sliding arms, two extension tubes, and two ordinary goose-neck lamps fitted with one-hundred watt bulbs. It is well to carry also a developing tank and some standard prepared developer. Films may easily be developed each night and carefully checked for omissions. This checking is made reasonably simple in my own case by the fact that I keep a careful index of every photograph, recording the date, place, person, subject, and collection or library from which the material is obtained. The collection and library as well as an identifying number are easily photographed with each manuscript. Identification and number may be on a simple typed slip or a regular holder with movable letters and figures. The size of the original may be shown by established measuring marks on the baseboard. Each roll of film also is identified by a number, photographed at the beginning and the end.

A scientific knowledge of photography is not necessary in order to use the camera as a research instrument. Careful observation of results and some idea of the fundamentals of lights and shadows are helpful. The research worker is primarily interested in obtaining the best possible photographs in the least possible time. He may be compelled to compromise between quality and quantity. He cannot spend too much time on artistry. The perfect negative, however, is worthy of attempt because of the possibility of enlarging it for future use as illustrative book material. **For the beginning photographer of ordinary manuscripts the two fundamental things to remember are: first, keep lights as uniform as possible over the field to be photographed; and second, be sure that the camera is in focus.** The goose-neck desk lamps are conveniently carried, but care must be exercised in placing them. Turn the shades so that the rays cross over the manuscript. A magnifying glass is helpful in focusing, par-

ticularly on newspapers. The perfectly focused negative, regardless of the size of the manuscript photographed, is easily read.

The length of exposure in copying varies with the intensity of the light used, the size of the diaphragm opening, the color of the paper which is being photographed, and the nature of the film employed. Practice alone can establish the best exposure for any particular equipment. The use of a dependable exposure meter is highly recommended. The f:9 diaphragm opening has proved the best in my own work. It is small enough to give clear-cut lines in the photograph, and yet it permits enough light to ascertain whether the manuscript is in proper condition, when using the Fuldy attachment, without opening the diaphragm with each exposure. **Where single sheets of paper of somewhat uniform size are being photographed, there is no need for repeated focusing.**

The cheapest and perhaps best general film for ordinary reproduction seems to be the regular positive stock. This film with the f:9 opening and two one-hundred-watt bulbs photographs black and white papers at an exposure of about one second; yellowed newspapers may run to three seconds. Allowances must be made for the difference in intensity between direct and alternating current lights, and also for extremely bright days. Filters are valuable, but longer exposures must be made when they are employed. Panchromatic film such as Du Pont Micropan should be used and especial care taken in copying graphs, charts, and cartoons which are intended for illustrations in books.

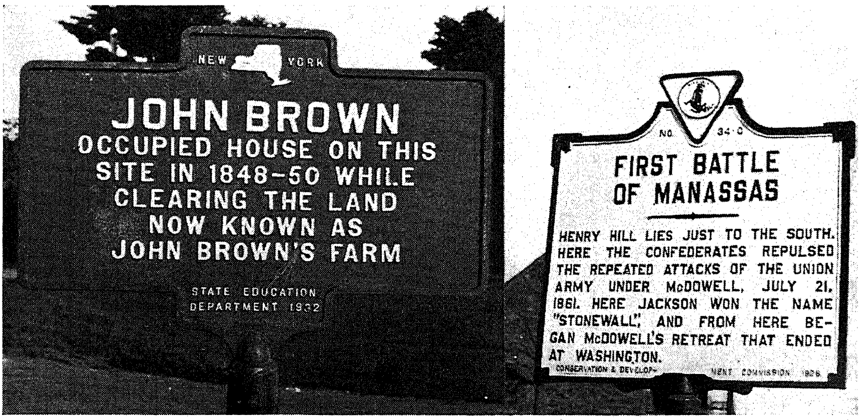
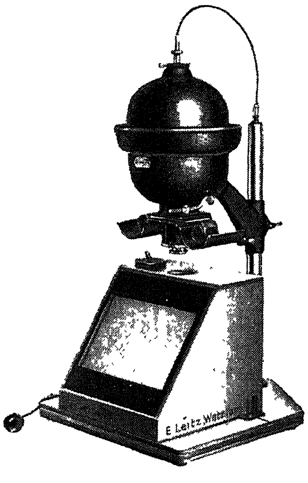


Fig. 204 Highway Signs which Give Historical Information Should be Photographed. Photos by W. D. Morgan and James A. Barnes

The most economical method of buying film is in bulk; the two hundred-foot lengths have many advantages. The traveling research worker, however, must learn to load both his cartridges and his developing tank in darkness. Bathrooms and closets are most frequently pressed into service as darkrooms, and one often finds that there is no place for attaching the safety lamp. A little practice makes it possible to load in complete darkness almost as quickly as with a lamp. An infallible test for determining the emulsion side of the film is to touch it to the tongue because the tongue sticks to the emulsion. Practice and observation, while they may not make of the researcher an expert photographer, will soon lead to qualifications sufficient for his work.

The student may use his material in two ways: either make enlargements on regular photographic paper, or else use a projector. For concentrated study enlargements on paper are preferred. Projection of the negative film itself of that material which is to be used only a few times is thoroughly satisfactory. The total cost per page when used in this manner is only a fraction of a cent. If repeated projections are to be made, it is safest to make them from positive prints. By carefully reading the special chapters on developing, copying, making positives, and projecting, a thorough understanding of this subject may be acquired.

The photographic method of research is certainly more economical and much more rapid than any other employed; it is also far more accurate. On a research trip of more than fifteen thousand miles the writer found no objections to the use of the camera. Owners of manuscripts and documents are easily convinced that misinterpretation and misquotation are less likely to occur when the material is photographed than when copied by hand or typewriter.



This Enlarging, Reading, and Projection Outfit, known as the Vokom, can be used for Examining Negatives or Positives. A small Mirror is attached for throwing the Image upon a Projection Screen. Note Ventilating Ring around Lamp Housing for use with Higher Power Bulbs

COPYING BOOKS AND MANUSCRIPTS

FRANCES W. BINKLEY CHAPTER 17

For the copying I do in my study the camera is mounted on the Leica arm which slips over a 4-foot upright fastened to the table. On the table beneath the camera concentric rectangles are drawn, corresponding to the sizes given in the Leica tables for use with the front lens. Along the top line of each rectangle there is written the helical focus to be used for copying that size, the distance of the camera from the object, and the amount of reduction. There are five of these rectangles, from 8 x 12 to 13 x 19 inches. A plumb bob dropped to the center serves as a check on the position of the camera. Very satisfactory results may be obtained in focusing by measurement with this arrangement, and it is more convenient than the copy attachment excepting in copying material that varies greatly in size.

If the camera is moved from its original position on the Sliding Arm to the Sliding Focusing Copy Attachment, the lens position is moved to one side and the field no longer corresponds to the rectangles as drawn on the table. (In the Fuldy Copy Attachment that I use the center is 2 inches to the left of the original center, when the Leica is attached directly to the Sliding Arm.)

It is necessary to use a supplementary lens or an extension tube to focus by measurement. If the various extension tubes are to be used between the Leica and the lens the supplementary lenses are not required. In this latter case use the tables given in the chapter on copying. In case a definite checkup is required the single exposure Leica is of value for securing exact focus for the various extension tubes, as well as the different positions of the Leica lenses.

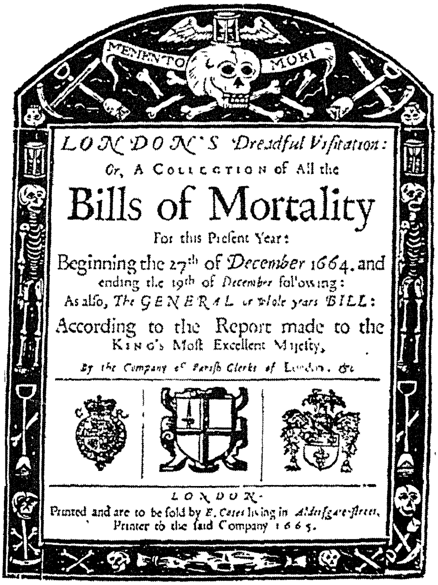
I have found that the f:3.5 lens plus the front lens No. 1 meets all ordinary needs in copying. It is a good lens combination for general work. However, where the type of material to be copied varies from such small objects as postage stamps up to newspaper-size pages, it would be convenient to have an additional lens or use the ground glass copy attachment. The smaller apertures give better

definition, and it is a good plan to make stop f:12.5 or f:18 the usual aperture in copying. It is possible, however, to make legible copies with as wide an aperture as f:6.3 and this of course speeds up the exposures. The character of the material to be copied must be taken into account in judging the limits within which the aperture may be opened. Since the smaller aperture means greater depth of focus, it is not necessary to re-focus even in copying very thick volumes, when the lens is stopped to f:18.

The Model F or G Leica (with focal plane shutter) make double exposures impossible and are probably the most satisfactory models to use in copying. Earlier models can be adapted by the use of a slow exposure timer. If enough light is used to reduce exposures to one or one-half second, there will very likely be considerable variation in density unless the exposures are automatically timed.

The Model FF camera may be used in long copying jobs, because of its greater capacity of film.

With the standard camera a half-dozen or more magazines may be loaded in the morning and reloaded in the changing bag if they are all exposed in the course of the day. (I keep a can in the changing bag supplied with film cut in advance into 5 foot strips.) This is very satisfactory for occasional copying, but in continuous work loading the magazines and changing them in the camera takes



MEMENTO MORI

LONDON'S Dreadful Viſitation:
Or, A COLLECTION of All the
Bills of Mortality
For this Preſent Year:
Beginning the 27th of December 1664. and ending the 19th of December following:
As alſo, The GENERAL or Whole years BILL:
According to the Report made to the KING's Moſt Excellent Majeſty,
By the Company of Pariſh Clerks of London, &c.

LONDON.
Printed and are to be ſold by E. Cotes living in Aldersgate-ſtreet, Printer to the ſaid Company 1665.

Fig. 205 Title Page Showing the Lists of Deaths from the London Plague of 1665. Photo by F. G. Ludwig, Yale Library

up a disproportionate amount of time. There are, however, comparable disadvantages with long rolls.

The Eastman or Du Pont process or positive safety films, bought in 200 or 400 foot rolls, are satisfactory for copying any black and white material. This safety film gives good contrast, and can be processed in a dark room with yellow light, a considerable convenience for the inexperienced worker. In copying colored material the panchromatic emulsions may be used. A document mimeographed in violet ink came out very badly on the positive film, but gave an excellent copy on Du Pont Micropan. Dr. Bendikson of the Huntington Library has published a number of articles (Library Journal, Oct. 1, 1932, Sept. 15, 1933, etc.) describing his methods and results in copying colored, faded, blotted and charred documents.

In copying material printed on thin paper it is necessary to interleave with white, to prevent the page underneath from showing through. Where the ink on one side of the page shows through on the reverse side I interleave with black, as this reduces the contrast and may eliminate the show-through on the negative.

Spring clips and rubber bands may be used to hold the paper flat in copying, or a piece of plate glass may be placed over the object. Glass is troublesome to use as it must be watched carefully for reflection and flare. In a library where the equipment is available the camera may be mounted on the photostat machine, so that the photostat copy holder and illumination can be utilized.

Two desk lamps with 100-watt bulbs give adequate illumination for copying, with a slow exposure. They may be placed one on each side of the object, the lamp placed 18 inches above the outer edge. This is not a perfect lighting system, as there is a variation with the size of the page copied. This variation however does not visibly affect the density of the negative (or length of exposure) in copying up to folio size pages. When newspaper-size pages are copied it becomes necessary to use two lights at each side. Care must be taken to avoid a flare spot on the curve of the page in copying bound material. When the paper has a glossy finish, tissue paper hung over the lights will increase diffusion.

With two 100-watt lights, placed as described, and an aperture of f:18 the exposure will be between 4 and 6 seconds on process film. Two seconds will result in a negative too light to be read easily in the projector, 8 seconds will be too dense. By substituting Photofloods for the 100-watt lamps, the exposure can be reduced to one second, and by enlarging the aperture it is possible to copy with an exposure of 1/20th second. There is no appreciable decrease in contrast with the use of photofloods, or with the use of Cooper Hewitt lights.

Since the time necessary to turn pages and arrange the document is always longer than the actual exposure, there is usually no advantage to be gained in working close to the limit of good definition with a wide aperture.

The small tank may be used for occasional films, but for developing a number of strips, the most satisfactory method seems to be simply to stand the film on edge in a deep tray, drawing it out to prevent adhesion in curling. Several strips may be handled at once in this manner and with an assistant present to hand the strips a large quantity of film may be developed within a short time, without any equipment except the tray. Where exposures are as standardized as they are in copying there is no great need for developing by inspection. In copying printed and written materials, the beginner must not forget that he is aiming at contrast rather than the soft tones sought in pictorial work. Emphasis in developing should be on securing contrast. There is little difficulty in obtaining adequately fine grain results with the process films.

Extreme care is necessary to avoid scratches and spots since they may obliterate essential words or letters of the document copied. The film should be touched only on the edge, and should not be allowed to drag across the side or bottom of a tray, where sediment may scratch it. Chamois used in wiping the film before drying should be free from grit.

Where negatives are valuable it is a good plan to give them a second bath in fresh hypo and a double period of washing to insure permanence.

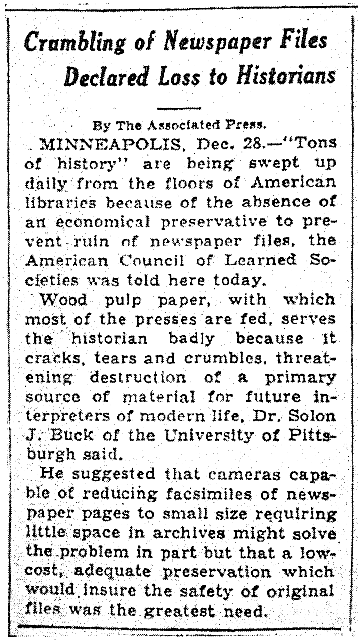
As soon as they are well dried the film strips should be rounded at the ends and placed in the containers. It is said to be advisable to roll the film with the emulsion side out.

The need for cleanliness in the dark room is frequently mentioned and should be called most emphatically to the attention of those whose darkroom, as is often the case with amateurs, is in the basement or the attic, where there is apt to be a good deal of dust. Film that is allowed to become dusty soon becomes scratched. It should not be dried in a room where spilled hypo has dried and crystallized. The amateur engaged in copying will produce a much greater bulk of film negatives than would likely be produced in pictorial work, and it is therefore necessary to care for a considerable number of strips if processing is done at home.

Making and Using Film Copies . . .
The Clerical Side

A system of filing and identifying negatives is an important factor in putting a collection of film copies to the best account. Most of us follow the line of least resistance and if there is a good deal of bother about unwinding film and searching for the piece wanted we are inclined to neglect the film copies, no matter how excellent the photography may have been. The following plan fits my own needs and might be adapted to the use of others.

The film strips are numbered and filed under headings that parallel those in a general file of notes and documentary material.



Crambling of Newspaper Files Declared Loss to Historians

By The Associated Press.

MINNEAPOLIS, Dec. 28.—"Tons of history" are being swept up daily from the floors of American libraries because of the absence of an economical preservative to prevent ruin of newspaper files, the American Council of Learned Societies was told here today.

Wood pulp paper, with which most of the presses are fed, serves the historian badly because it cracks, tears and crumbles, threatening destruction of a primary source of material for future interpreters of modern life, Dr. Solon J. Buck of the University of Pittsburgh said.

He suggested that cameras capable of reducing facsimiles of newspaper pages to small size requiring little space in archives might solve the problem in part but that a low-cost, adequate preservation which would insure the safety of original files was the greatest need.

Fig. 206 Newspaper Clipping Warns Against the Loss of Valuable Records

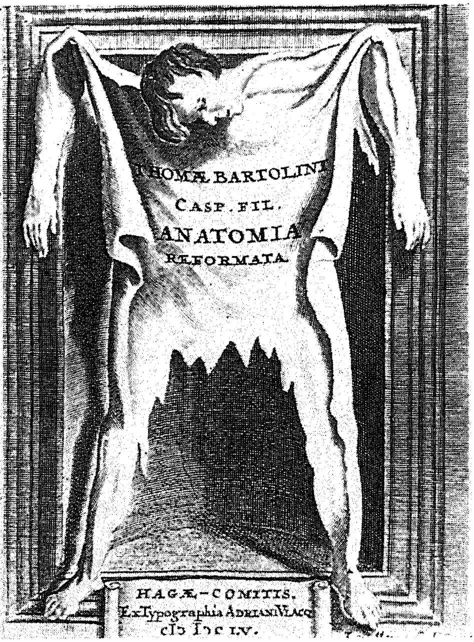


Fig. 207 Cover of an Early Medical Book Copied for Later Study

A record of the material copied is photographed in each case and becomes part of the negative, serving as a label.

The first exposure on each strip of film copies a large number that can be read on the negative without a lens, and a good deal of eye strain is avoided in identifying film strips by this large number at one end. The numbered series serves as a check against the loss of film in process or in use.

The second exposure copies a label, which contains the following information:

a. title of document
b. filing designation
c. photographic conditions
d. number of pages copied

It is not necessary to use an entire frame for this label, as it may be placed alongside a title page and photographed in that position. After the entire strip of film has been exposed, the number of pages copied may be noted on the original label, and if the document

has not been completed the label may be carried forward to the next film strip. The original label is eventually filed in the general file, with other notes, and serves as a cross reference to the film. In special cases, as in copying a series of documents, it is convenient to keep a list of the contents of the film strips, taken from the labels before they are filed.

The entry on photographic conditions may be referred to in comparing the results of various methods of copying, and also in planning retakes where the copying has not been successful. If a large amount of material has been copied in the course of travel, a note on the label of the condition of the document, color of ink and paper, and the exposure given, will explain the results in the case of a poor negative and may be taken into account in ordering retakes. If missing pages or other variations in the document are noted on the label it will save turning again to the original in checking over the film negatives.

It is a good plan to number the exposures or frames in copying. Small cardboard squares which stay in place when dropped at the corner of the page are desirable (mine are hat check numbers). These frame numbers are used in collating enlargements or in giving orders for enlargements to be selected from a film strip. A running title, typed on a narrow piece of heavy paper and placed at the bottom of each page, is also useful in identifying enlargements and in identifying pages as they are read in the projector.

To add the frame number and running title, interleave pages to prevent show-through, and attach spring clips to hold the pages flat,—all occupies about twice as much time as the actual exposure in copying. In my experience, however, the time is saved twice over in the future use of the negatives. To assort the enlargements from a number of film strips, if they are not numbered, will sometimes take as much time as the photographic process itself. On one occasion, before I adopted the numbering system, I had copied several slightly varying drafts of a single document, had 75 enlargements made, and found it was necessary to compare each enlargement with the original in order to be sure the pages were arranged in correct sequence. It took as much time as a jig saw puzzle.

An advantage of the film copy method is that proofreading is not required. It is necessary, however, to look over the film, with a lens, first to see that it is satisfactory from the photographic point of view, and then to discover if what we might call *clerical* errors have occurred.

Copying Mistakes and Their Remedy

Faults in photography most likely to be encountered are, first, those in exposing, such as errors in focusing, the object not being in the center of the field, over or under exposure, *spots* caused by improper illumination or by reflection from bright objects near the page copied, and the like. Second are the accidents in processing, such as scratches, pin holes and water spots, and over or under developing.

The most likely clerical errors are mislabeling of documents, or skipping pages. The following device serves as a check on missing pages, so that it is not ordinarily necessary to check them on the finished negative.

I count thirty pages in the document and place a marker at the end. If the camera counter, the frame numbers, and the marker in the document coincide at the end of the strip, it is reasonably certain that no pages were omitted. If an error has been made the best way to correct it usually is to retake the whole strip. This avoids isolated pages, taken at a later time, which must be spliced on to the film strip.

Film Storage

I keep the Leica film strips in small tins, labeled on the top. These can be arranged in rows in a shallow drawer and treated, so far as filing is concerned, as if they were folders in an ordinary vertical file. The label on the tin corresponds to the file designation photographed on the film and also, of course, to the headings in my general file.

Where there are a number of short takes on a strip, I cut them apart, disregarding the strip number, and file the short slides with other material in the general file. Paper folded and pasted on the back of a folder forms pockets to hold the film.

The best advice on storage that I have been able to obtain indicates that proper processing is the prime condition of film permanence. There is apparently no great danger of loss if the film is kept in a reasonably cool place. Since almost all my film is on the acetate base there is no more fire danger involved in keeping it than in keeping papers of any sort.

Reading the Negatives

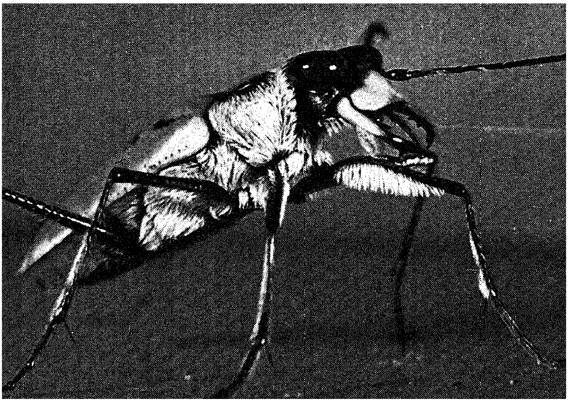
After the copies are made and filed in some safe and easily accessible manner, the problems involved in using them are relatively simple. The film may be used in short or long strips, on reels, or the frames may be cut apart and mounted individually in cards, to be used as slides. When suitable reading devices are available the film may be projected to a convenient size and read at close range in a light room, so that a typewriter may be used in making notes. If the projector used will not allow a light at the desk, it is still possible to record notes on a dictaphone as the film is studied.

When enlargements are desired, they may be greatly reduced or made as large as required. Copies of newspaper clippings, for example, may be enlarged to twice the original size, or on the other hand a series of letters may be reproduced to fit a 3 x 5 card file. Such papers as Photostat R, Insurance Bromide, and Haloid Record are satisfactory for enlargements.

If a few frames are to be selected for enlargement from a long strip of film, the enlargements may be indicated by the frame number or by short pieces of string tied into the perforations.

In planning for enlargements in large quantity, it must be taken into account that they add a large sum to the very low cost of the film copy, as

well as increasing the bulk of material to be stored. To the cost of making the enlargements should also be added a charge for clerical work in assorting and checking over the finished copies. It may also be decided to mount the enlargements, to get away from the tendency of the paper to curl, and this adds another charge. If a suitable projector is available the beginner in the field of film copy ought by all means to give a fair trial to reading the film by projection before deciding out of hand that all his film copies must be enlarged.



Tiger Beetle J. M. Leonard

THE MINIATURE CAMERA FOR MINIATURE MONSTERS

J. M. LEONARD **CHAPTER 18**

The photographer who is weary of portraits and pictorials or who is bored by the discussions of purist versus creative may take new hope. If he wishes to combine amusement and education with a host of interesting photographic problems, he should explore the world of miniature monsters which awaits him in his own backyard. He will find a life as fascinating and as bizarre as any that ever roamed the hot sands and the reeking swamps of prehistoric times.

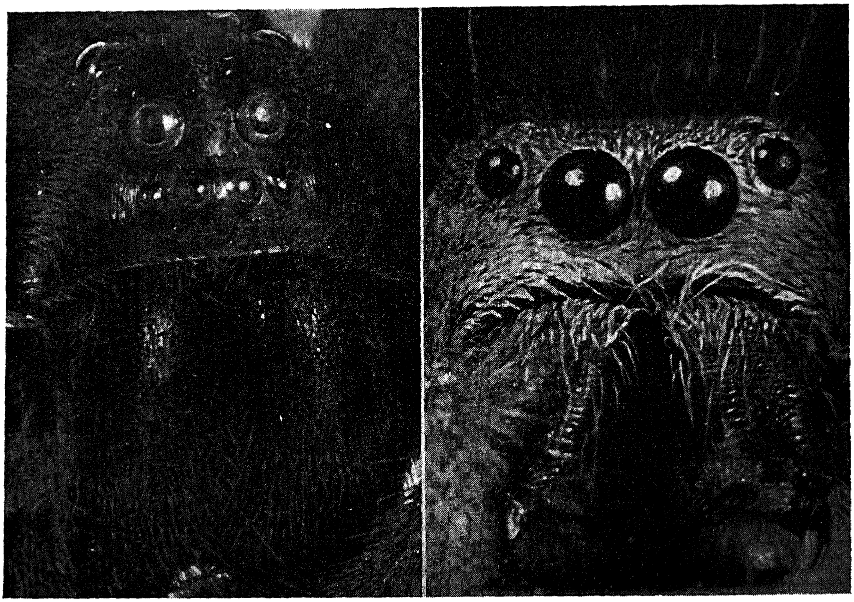
Such an exploration, through the eye of the camera, will reveal creatures clothed in bone, in feathers, and in hair; creatures with from two to eight eyes, and from one to nearly thirty thousand lenses or facets to each eye; creatures so weird in appearance that they seem to belong to another age. These are the insects and the spiders. Their variety of form is boundless and in brilliancy of color they equal if not surpass the most gorgeous flowers. Their habits and their social conduct are of such absorbing interest that the insect photographer need not feel surprised should he suddenly find himself more interested in studying the actions of the insects than in photographing them.

Entomologists estimate that there are a half million or more known species of insects. They constitute by far the largest group of living creatures and greatly exceed the combined total of all others on the earth, in the air, and under the water. Doctor Frank E. Lutz of the American Museum of Natural History states that there are approximately fifteen thousand species of insects to be found within fifty miles of New York City, and nearly eleven thousand species within the state of New Jersey, and these, bear in mind, are species and not individuals. The photographer who takes up this branch of work will never lack subjects. Also he will have a year around hobby, for the insects may be photographed alive in the field or may be mounted and saved for the long winter evenings.

Catching the Insects

Although insects are so numerous and so widely distributed a few hints as to where to look and what to look for might be helpful. The collector doubtless needs no suggestions as to where to find such household insects as the roach, silver fish, clothes moth, house fly and mosquito. These, however, constitute a very small percentage of the thousands of varieties which lie beyond the screens and the front door.

Fig. 208 Head of Wolf Spider Fig. 209 Head of Jumping Spider
Note How Eye Arrangement Differs



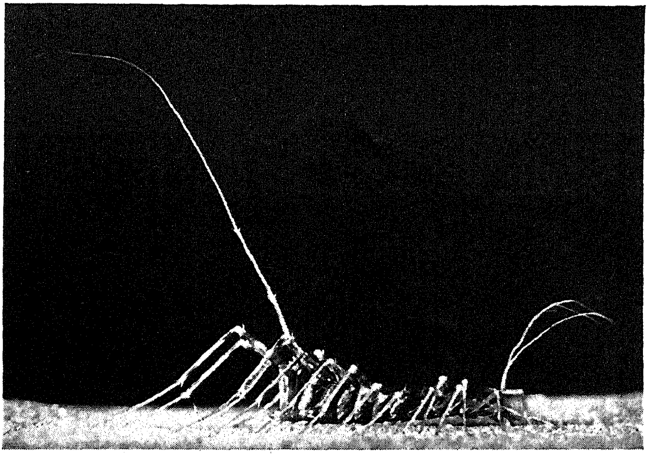


Fig. 210 The Northern Centipede which Lives in Houses

While many insects are much in evidence some of the most interesting ones prefer seclusion and their society must be sought. Turning over an old board or a rock in a field may admit one to the private lives of a few crickets, a family of sow bugs, or a miscellaneous collection of beetles. Other insects will be found under bark, in rotten wood, in flowers, among the roots of plants, and in fact practically everywhere that the careful collector cares to look. The chief requisites of a collector are active curiosity, quick fingers, and nimble legs. For the capture of moths, butterflies, dragon flies, or other flying insects a net is essential. This may be purchased for a reasonable price from any dealer in entomological equipment.

While all insects are interesting photographically, there are a few of the common ones which, because of certain outstanding points of interest, should appeal to the beginner in insect photography. The spiders—which by the way are not insects but are of the class *Arachnida,* order *Araneida*—are interesting because of their ferocious appearance and the number and arrangement of their eyes (figs. 208 and 209). The normal number of eyes is eight and all of the eyes are simple: in none of them is the outer layer divided into facets as in the compound eyes of insects. The normal arrangement is regarded as two rows, each containing four eyes, but they may be found in three and even four rows. Grasshoppers are interesting because of their smug expressions (fig. 211). *Scutigera Forceps,* the northern centipede which lives in houses, appears like a bleached carcass on the desert when photographed on sand against a black background (fig.

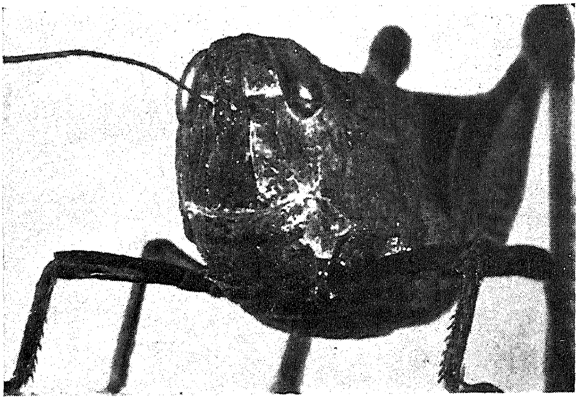


Fig. 211 Grasshopper
Elmar 135mm lens, S. F. Attachment, 60mm ext. tube, 16 seconds at f:18, DuPont Superior Film

210. The larvae of many of the large moths such as *Cecropia, Promethia,* and *Cynthia* look like prehistoric dragons in the photographic enlargements. The points of interest are endless but the experimenter will soon find his own favorites.

The Camera Equipment

The camera used in photographing insects must fulfill several important requirements if the best results are to be secured. Ground glass focusing is essential because of the very small depth of focus which is available when the object to be photographed is only an inch or two from the lens. The equipment selected should be such that the distance between the lens and the film may be varied sufficiently to produce either photographic reduction or enlargement of several diameters. The range in the size of insects is such that a fixed amount of bellows extension will not serve for both the large and the small ones. The image of a praying mantid would have to be considerably reduced before it could be recorded on a 35mm film, whereas a mosquito or a fly would need a corresponding amount of enlargement to bring out any detail.

The Leica camera, which is used by the writer, fulfills all of the essential requirements. The sliding focusing copy attachment provides ground glass focusing, and the lens extension tubes which are used with it permit a wide range of photographic reduction and enlargement, particularly when used with lenses of different focal lengths. As an added advantage the copying attachment and camera may be mounted on a tripod and used in the field for photographing live insects. The question of which model of the Leica to use is significant only in one respect. Any model is satisfactory but the Model F has the outstanding advantage of including speeds between 1 and 1/20 second, and it is in this range that many of the insect exposures will be made.

The accessory equipment for this branch of work will vary with the ideas of the individual and with the state of his pocket-book. A fairly comprehensive list is as follows:

Sliding Focusing Copy Attachment and Magnifier
30mm, 60mm and 90mm Extension Tubes
Elmar 35mm lens..........Elmar or Summar 50mm lens
Lens Shade..........................Wire Cable Release
Ball Jointed Tripod Head...............“Triax” Tripod

For field work the 50mm lens and the 30mm tube generally will be sufficient. This combination in connection with the Copy Attachment will produce a .82x magnification of the image which is about all that can be tolerated when working with a live insect of average size. If greater magnification is used it will be difficult to obtain critical focusing because of the reduced depth of focus combined with the need for fast work when photographing a live insect. The additional tubes and the 35mm lens will be found useful for higher magnifications when the work is done indoors under controlled conditions.

Photographing in the Field

Photographing the insects in their natural haunts will provide the occasion for many a long and interesting walk. The woods, the fields, and the shores of ponds and streams are teeming with life. The close observer will find ceaseless activity and industry to an extent unrivalled among living things. He will find every trait and characteristic that can be found in human beings and many others besides.

For field work, the equipment should include the sliding focusing copy attachment and magnifier, a 30mm tube, lens shade, tripod with ball jointed head, and wire cable release. In addition, a can of ether or carbon tetrachloride, a small glass jar and a medicine dropper will be found useful.

A little experience in trying to photograph a live active insect will soon show the difficulty of doing so. Some insects are easily frightened and others appear to have a constant urge to go somewhere. Usually by the time the camera is set in place and the somewhat critical focusing has been done, the insect has succumbed to this urge and is nowhere to be seen. The job will be made much easier and the chances of a successful picture increased if the insect is placed under better control.

The following method has been used with good results:

1. Select a twig, shrub, rock or any other place where you would like to have the insect resting when it is photographed.
2. Focus the camera on the particular spot selected.
3. Next catch the insect and place it in the jar with a few drops of ether or carbon tetrachloride. It should be carefully watched and should be removed from the jar as soon as it appears stupefied.
4. Place it in the spot previously focused on, arrange its legs in a natural position, quickly check the focus and take the picture.

If it has been etherized just the right amount it will be able to cling to the twig or leaf but will not be able to crawl or fly away for a minute or so.
Too much ether will kill it, and too little may enable it to leave before the picture is taken.

The insect may be mounted in the field if desired and thus kept under more complete control. About twenty years ago Dr. David Fairchild of Washington, D. C., made a number of very interesting insect photographs which were published in the National Geographic Magazine and later in book form as ''The Book of Monsters''. Dr. Fairchild describes his method of mounting as follows:

"Cover the top of a small block of wood with a thin, even coating of paraffin or ordinary candle wax by letting the drippings of the candle fall upon it. Pick a large leaf and turn its upper surface down upon the wax, before it cools, and let it stick there; this will give a natural looking ground for the insect to stand upon. Hold the insect over the block of wood and arrange the legs in as natural a position as you can with a long needle or fine dental tool. Then fasten each foot in place by heating the needle in the candle flame and pricking a hole in the leaf just under each foot so that the wax will come up through the leaf and hold it fast." The insect is anesthetized just before the mounting operation is undertaken, and is photographed immediately after it is mounted.

There are times when it pays to proceed with caution and to observe closely what the insect is doing instead of immediately capturing and etherizing it. An interesting series of pictures may be the reward of restraint and patience. The insect may be engaged in an operation which is seldom noticed and less frequently photographed. Careful scrutiny may show a cricket laying its egg through a long tube which has been thrust into the earth, a jumping spider dancing before its mate or a praying mantis depositing its egg mass as shown in figure 213.

The mantis series resulted from wondering why this insect was lightly tapping the stick with the end of her body. It seemed to be an unusual procedure and was one which the observer had not seen before. After watching this seemingly futile performance for twenty minutes the observer was rewarded. The mantis began to exude a frothy substance from her body and carefully worked this into place on the stick. As it was apparent that this was the beginning of the egg mass the Leica was hastily set up and a picture was snapped. Pictures followed at ten minute intervals for the two hours and twenty minutes she required to complete the operation.

Selecting the Correct Photographing Angle

In insect photography, as in any other kind, the position of the camera in relation to the object being photographed is an important

factor in determining whether or not the picture will be interesting. A photograph of a man or a horse taken from an elevation with the camera pointing directly downward would not be particularly pleasing and would give little idea of what the subject really looked like. Following this line of reasoning best results will be obtained if the camera is in the same plane as the insect, or in other words, at insect level, although this rule may be varied by angle shots from slightly above or below the subject. This point is illustrated in figure 212 which shows two moths, one photographed from above and the other from the side.

It is for the reasons given that the "Triax" tripod is suggested for field work. It is one of the few that is so constructed that the legs when spread out so that they are in one plane, cannot be raised above that plane. When the tripod is placed on the ground with the legs spread in this manner the camera will be only a few inches above the ground and will be rigidly supported.

The proper exposure time can best be determined by means of an exposure meter, bearing in mind that a correction factor must be applied if the extension tube is used. Using the 30 mm. tube and the 50 mm. lens set at infinity with the diaphragm at f:6.3 the exposure as determined by the meter should be multiplied by 2.2. It should be remembered that when an extension tube is used between the lens and the camera the f values of the diaphragm do not mean the same as when the lens is used without the tube. Moving the lens away from the film increases the size of the image at the plane of the film and therefore a given amount of light coming through the diaphragm aperture will be spread more thinly over the image than would be the case with the lens in its normal position in the camera. This is equivalent to reducing the f value and proportionately longer exposures will be required.

Field trips in search of insects will disclose other interesting subjects for the camera. The hog-nosed snake, the neighbor's cat

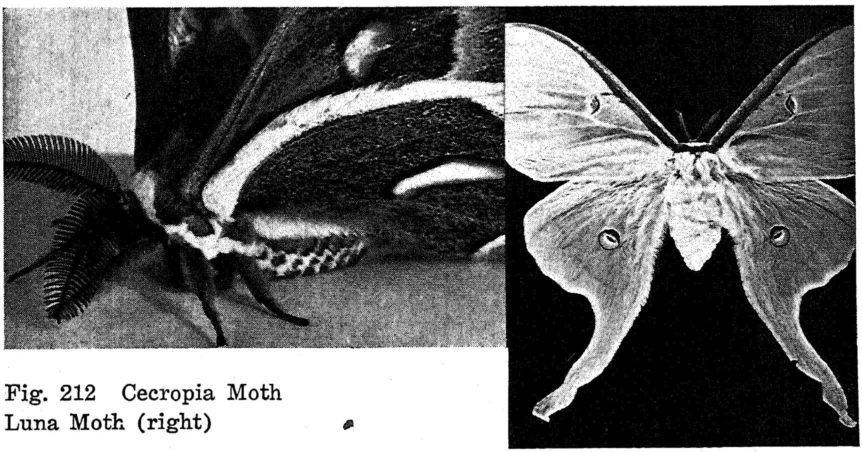
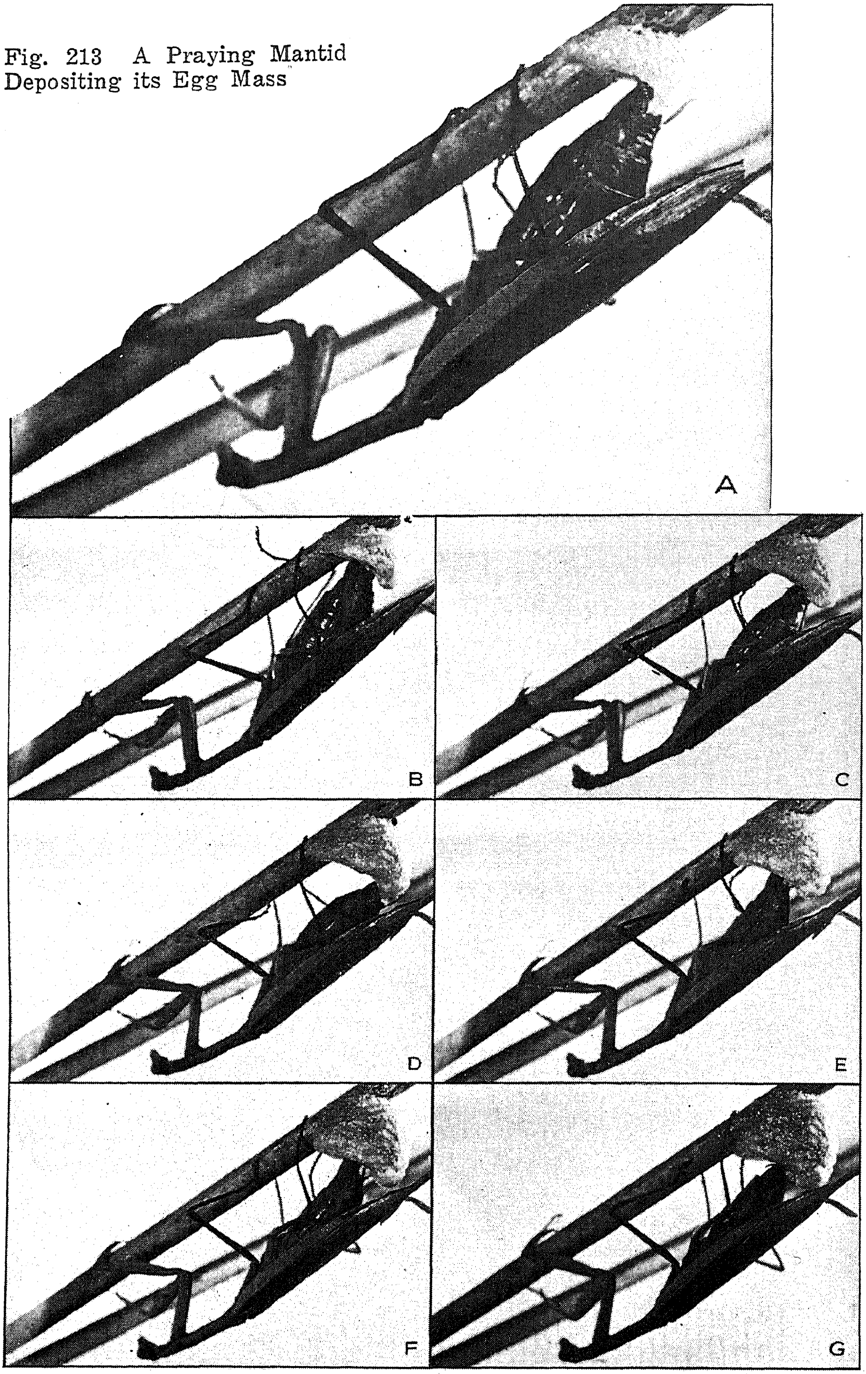
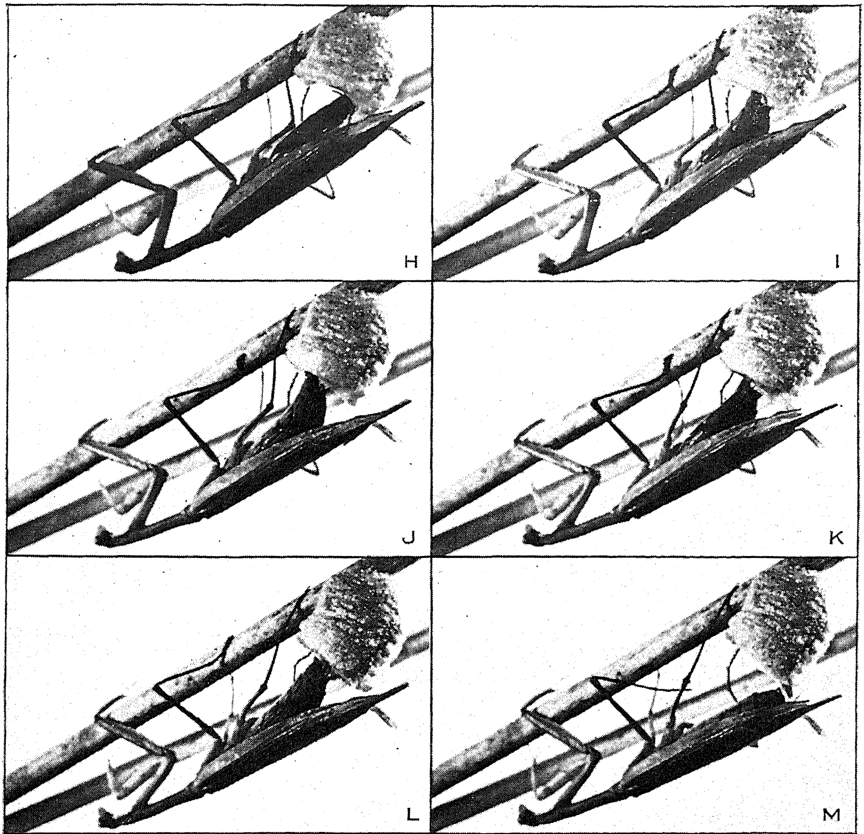
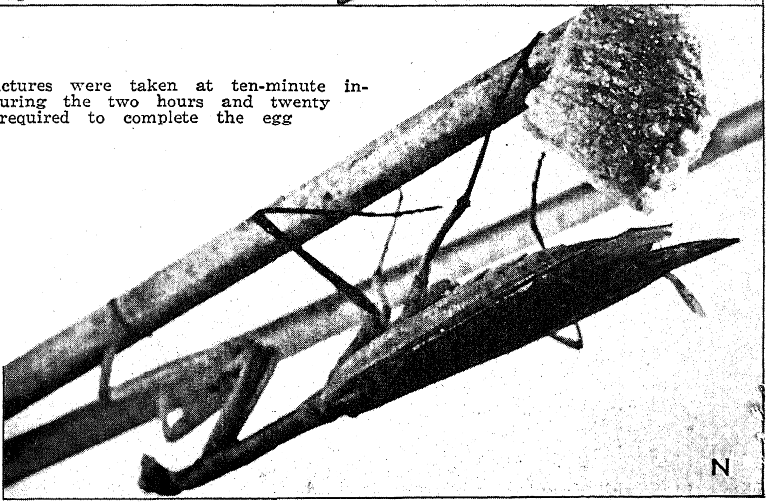


Fig. 212 Cecropia Moth
Luna Moth (right)

Fig. 213 A Praying Mantid Depositing its Egg Mass







These Pictures were taken at ten-minute intervals during the two hours and twenty minutes required to complete the egg mass

and the lizard (fig. 214) are among the many trophies of such rambles.

Bringing Home the Catch

If the insects are to be brought home to be mounted and photographed at leisure, instead of being photographed in the field, small straight sided bottles having large mouths and screw caps will be found convenient for transporting them. A word of caution, however, about properly segregating the occupants of the bottle. The writer, on one of his collecting trips, found some magnificent specimens of huge black and red ants. He captured a half dozen of the finest looking ones and placed them in a small cardboard box. He carefully brought the box home and opened it to find a grand collection of spare parts—legs, heads and bodies scattered about. In the midst of the destruction was the victor—minus all six legs—still waving avid mandibles in search of more victims. A safe rule is to have a separate container for each insect.

Moths and butterflies should be killed as soon as they are captured. This may be done by carefully but firmly pinching the thorax between the thumb and finger. If they are alive when placed in the container they will thrash about and injure their delicate wings.

Mounting the Insects

Insects which are to be photographed at leisure must be permanently mounted. This is a difficult job and, if naturalness is to be achieved, calls for steady hands and endless patience. There probably are many ways of mounting and the experimenter may wish to develop his own.

Fig. 214 Gila Monster

A method which was adopted by the writer after many experiments is as follows:

Take a piece of cardboard measuring about 2 x 3 inches for the smaller insects and proportionately larger for those of greater size. Cement to this a piece of Dennison's gummed cloth mending tape with the gummed side up. Place the etherized insect on this and putting each leg in turn in the proper position, moisten the gum around the foot with a small pointed stick which has been dipped in water. The events leading up to and following this operation are as important as the mounting operation itself. The live insect is carefully studied until all of the details of one pose are firmly pictured in the mind. This includes the position of the antennae and of

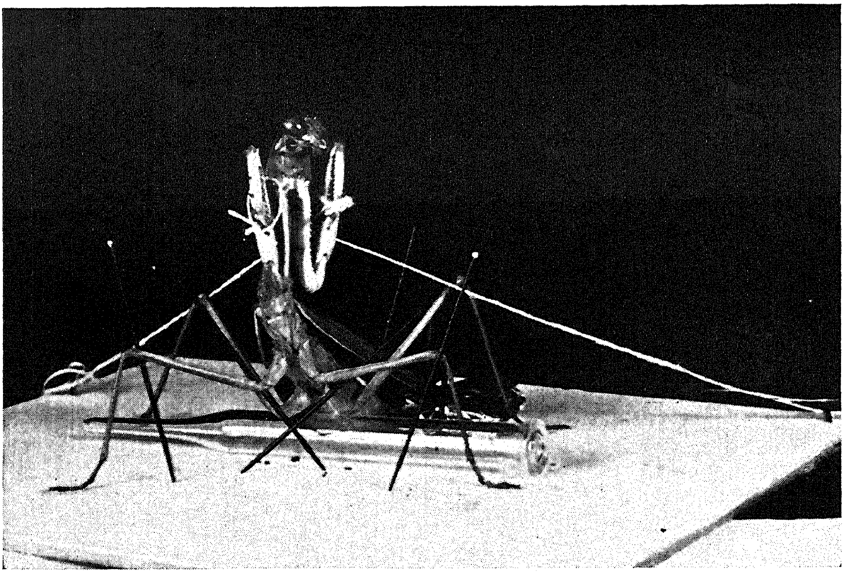


Fig. 215 A Praying Mantid—Showing one Method of Mounting

each of the six legs, the angle of the head and of the body, and the distance between the under side of the body and the mounting surface. The insect is then etherized. This may be done by inverting a water glass over it and placing a few drops of ether under the edge of the glass with a medicine dropper. Experience will show the proper amount, which varies greatly according to the kind of insect. A few drops suffice for a fly while some beetles and spiders literally must be bathed in it. Care must be taken to remove the insect after it is properly anesthetized. Too much ether will kill it, and the way the contracting muscles of a dying beetle will pull its six legs into a tangle would discourage the most patient experimenter. Place the insect quickly on the gummed tape and fasten each foot in the position it assumed when alive. After this job is about half done the chances are that it suddenly will come to life and pull its feet free so that the whole operation will have to be repeated.

When all legs are in place the insect is blocked up to the proper height by inserting under it small rolls of tinfoil or bits of cardboard. The head is held at a natural angle in a similar way or by letting it drop into the crotch formed by two pins which are stuck into the cardboard in such a way that they cross just under the head. The antenna may be held sloping upward to the front by a piece of cardboard so folded that one part of it rests flat on the mount forming a base for the other part which extends upward at the desired antenna angle. The antennae are carefully laid on the sloping piece. Antennae which are carried in a horizontal position may be held in place by a small block of tinfoil placed under them. Legs which tend to buckle in the wrong direction are braced by pins stuck into the

Fig. 216 The praying Mantid shown in Fig. 215 after the Mounting Pins, Blocks, etc., have been Removed

cardboard mount. Ordinary pins may be used but those are not as satisfactory as the pins used by entomologists for mounting insects. This pin is about 1½ inches long and has a very small head and a sharp point. After the insect is finally mounted and is blocked in a lifelike position it should be killed. One of the most satisfactory ways of doing this is by inverting a large mouthed cyanide bottle over the insect. The cyanide fumes do their work in a very few minutes. The insect is carefully put aside to dry and in four or five days the pins and blocking may be removed. The insect will remain permanently in the position in which it was mounted. Figure 215 shows a praying mantis which was mounted in a fighting pose by the method just described. Figure 216 shows the same insect as finally photographed.

The supplies and implements for mounting are few and simple. They are: a can of ether, a medicine dropper, some pieces of cardboard, a small sheet of tin or lead foil, a roll of gummed cloth mending tape, a tube of cement, one or two long flexible tweezers, some pins, and a few slender pieces of wood with needles stuck in their ends. The needles are used for arranging the insect's legs and antennae. One of them may be made more useful by heating the needle point and bending it into a very short hook. One more accessory which is almost a necessity is a binocular loupe magnifier such as is used by oculists. Lacking this a reading glass may be used but it should be mounted on a support so that both hands are left free to work on the insect.

The question has been asked many times as to how insects should be preserved to prevent decomposition. The answer is that preserving is not necessary for the reason that the insect wears its skeleton on the outside. The outer part of the insect's body is composed of a substance known as chitin. This is an organic chemical compound and the parts of an insect's skin which contain it are hard, tough and lasting. Spiders, however, require special treatment as otherwise the body will gradually shrink and collapse until it is flat and unnatural in appearance. Before mounting a spider the under side of its abdomen should be slit open and it should be thoroughly cleaned out. It should then be stuffed with cotton until it is filled out to natural size and appearance.

To prepare the mounted insect for photographing, a thin layer of fine sand may be sprinkled on the cardboard mount to produce a natural looking foreground. A piece of cloth or cardboard may be placed a few inches beyond the insect for a background. This may be white, black, or some shade of gray depending upon the color of the insect and the photographic effect desired. For a dead black background a piece of black velvet is excellent.

Lighting

Lighting a subject as small as an ant or a fly in such a way as to bring out the desired contrasts is difficult and requires much experimenting. Almost any source of illumination can be used, but the results obtained will be somewhat dependent upon the amount of control that can be exercised in the application of the light. The lighting originally used by the writer consisted of three 100-watt Mazdas in goose neck desk lamps. While fairly satisfactory results were obtained with this lighting arrangement it was not all that could be desired. The size of the light source was so large compared to the subject being photographed that it was difficult to produce the desired effects. Photoflood lamps may be used if it is desired to materially shorten the exposure time, but these too have the disadvantage of being much larger than the subject.

The most satisfactory lamps so far used were improvised from old style De Vry still projectors. This so called projector really consists of only a lamp housing with its support and a very good condenser system. Projection originally was accomplished by clipping a De Vry camera in front of the condenser and using the camera lens as the projections lens. The camera however is not necessary in constructing the insect spot lights. The first steps in adapting the projector are to remove the lamp housing from its support, discard the support and the transformer which it contains, and substitute a double contact bayonet socket for the single contact socket. The double contact socket is standard and may be obtained in any automobile supply store. A 50 or 100 watt 115 volt projection bulb will fit this socket and is the right size for the lamp housing. The housing should then be mounted so that it may be moved up and down or may be tilted. This requires only a little ingenuity and in figure 217 it is shown in use. It consists of a lead-filled lamp base, a rod with sliding clamp which ordinarily is used to adjust casement windows, and a brass coat hanger for adjusting the position of the lamp when the housing becomes too hot to touch. A piece of ground glass clamped in front of the condenser lens to diffuse the light completes the outfit. This lamp produces a brilliant concentrated spot of light ¾ inches in diameter at about 2½ inches in front of the condenser lens and a well diffused light at a distance of eight or more inches. The light has a value of 1500 to 1800 candles per square foot in the ¾ inch spot and about 600 candles at the 8 inch distance.

In arranging the lighting in preparation for the exposure a good general rule is to place lights on both sides of the subject with a

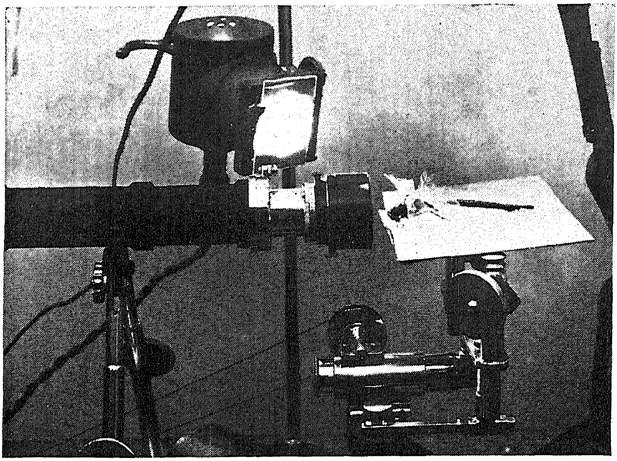


Fig. 217 Close-up View of Photographic Equipment Showing Position and Construction of Spot Light and Arrangement of Insect and Lens

third light above and to the front of the insect. In order to avoid flat lighting the lamps should not be equidistant from the subject, but should be so placed that proper shadows are cast. Care should be taken, however, to avoid multiple shadows. By changing the position of one or more lamps any desired parts of the insect can be thrown into relief. A useful combination of lights consists of two photoflood lamps with tracing cloth diffusing screens and a single spot light. The photofloods are placed on either side of the subject to give full and uniform illumination and the spot is used to bring out the desired contrasts.

Back lighting produces interesting results and seems particularly effective in the case of insects having semitransparent wings. Entirely different effects in wing photographs may be produced by back, front or cross lighting. An example of cross lighting is shown in figure 219. This is a photograph of the almost transparent wing

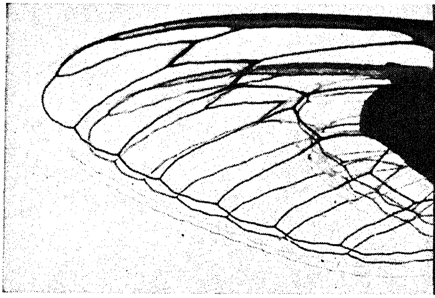


Fig. 218 Transparent Wing of Small Insect: Front Illumination; White Back-ground

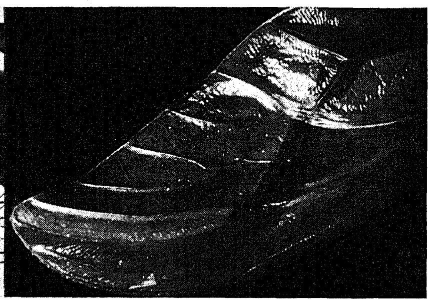


Fig. 219 Transparent Insect Wing, Cross-Illuminated Against Dark Back-Ground

of a small insect. The beam from a single spot light was directed across the surface of the wing in order to make the wing veins stand out in relief. In contrast to this, front lighting against a white background silhouettes the veins (fig. 218).

Many pitfalls will be encountered. The smooth shiny body of a beetle will reflect brilliant patches of light. Undesirable reflections will be produced by the eyes. The under side of the insect will appear on the print as a black area with no detail unless care is taken to place one or more lights at the level of the insects body or slightly lower. Many other difficulties will be encountered which can be solved only by experiment. In general, most of the lighting principles which are used in portrait work apply equally well to the photography of insects. The difficulty lies in the practical application of these principles. The subject is so small and the effects of the lighting are, in consequence, so difficult to judge that many times it is only when the final enlargement is made that the correctness of the lighting arrangement is known.

Ultraviolet Light

If extreme resolution of detail is required it will be necessary to depart from the usual sources of artificial light and to take advantage of the short wave lengths of the ultraviolet region. An inspection of the equation for resolving power of a lens will show that decreasing the wave length of the light used increases the resolving power.

The use of ultraviolet light for photography immediately suggests quartz lenses and quartz lamps, but these are very expensive and are not necessary for ordinary work. The usual types of camera lenses will transmit wave lengths from the visible spectrum down to about 3300 Angstrom units which is sufficient to give a noticeable increase in definition.

A convenient and relatively inexpensive source of light is the Black Bulb ultraviolet lamp manufactured by the Westinghouse Lamp Company and obtainable through any of their local offices. It is a mercury vapor lamp equipped with a standard screw base. It operates at 15 volts and comes in two sizes having 2 amperes and 5 amperes current consumption respectively. The lamp transmits ultraviolet wave lengths from 3200 to 4200 Angstrom units, which are the long waves of the ultraviolet region and which, incidentally, are of high actinic value in photography. They are not harmful to the eyes.

Great care should be taken not to connect these lamps to the usual 110 volt house lighting circuit as they will immediately burn out. They should always be used in series with a suitable reactance or resistance depending upon whether they are to be connected to an alternating or a direct current source.

It is advisable to use two lamps in order to obtain balanced lighting of the subject, and the exposure time will be reduced if they are used with reflectors. In selecting these it should be remembered that a reflector which is quite satisfactory for white light will not necessarily serve for ultraviolet. Probably the best compromise between reflection efficiency and availability of the material is aluminum oxide. This may be formed on the surface of any aluminum reflector by immersing it in a strong solution of lye. It should be removed and washed for examination at intervals of two or three minutes and the action should be continued until the aluminum has a uniform matte surface. *Just two words of caution—first make sure that the reflector purchased is not chromium plated on the inside, and second, do not breathe the fumes of the lye bath.*

The visible light from the Black Bulb is so faint that focusing is impossible and must be done by white light. While theoretically the ultraviolet will cause a shift of focus, practically this is so small that it is not noticeable in the finished picture. The exposure time will be much longer than with the usual sources of artificial light. Definite comparisons are difficult because of the lack of a convenient means of measuring the intensity of the ultraviolet light but the following may serve as a rough guide:

Two sets of exposures of the same subject were made, using in one case two Black Bulbs in aluminum reflectors and in the other case one small spot light equipped with a 100 watt projection bulb. The lights in each case were placed at about the same distance from the subject. To produce negatives of equal density required about 150 times as long an exposure with the ultraviolet as with the white light.

The improvement in definition resulting from the use of ultraviolet light is shown in figures 220 and 221. These are photographs of the eggs which

Fig. 220 Eggs of Canker Worm Photographed by Ultra-Violet Light

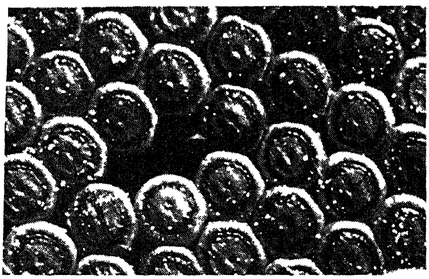
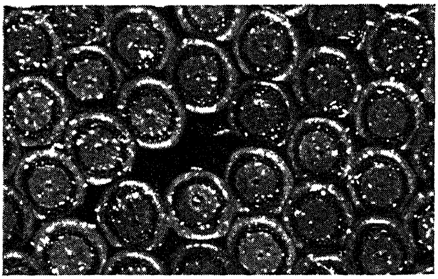


Fig. 221 Same Section of Egg Mass Photographed by Mazda Light



produce the inch or canker worm so destructive to foliage. The pictures were taken on the same roll of film with the same lens so that all conditions except the light source were identical.

Increased definition is only one of the results of the use of ultraviolet. Experiments conducted by Dr. Frank E. Lutz and others indicate that insects see by ultraviolet rather than by the light to which our eyes respond. By using the short invisible waves to photograph the insects we are able to picture them as they possibly look to each other. Comparison photographs of the same insect taken by white and by ultraviolet light will in some cases reveal interesting differences in the marking. Figures 222 and 223 show two photographs of a butterfly taken in one case by white light, and in the other by ultraviolet.

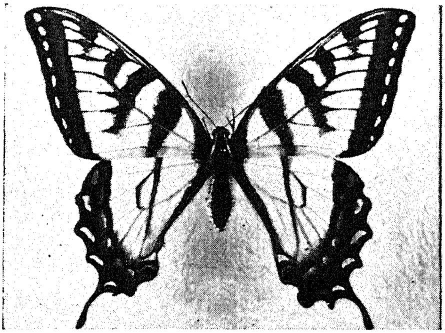


Fig. 222 Yellow Tiger Swallow-Tail Butterfly. Photographed by Mazda Light

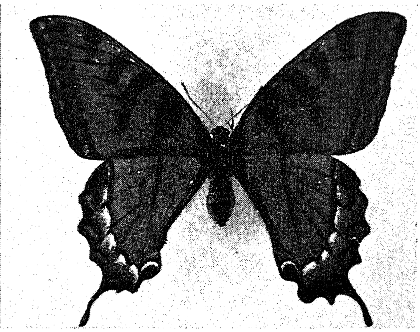


Fig. 223 Same Butterfly. Photographed by Ultra-Violet Light

The determination of the best film to use in ultraviolet photography must be left to the reader to determine, as the writer has not yet had time to make complete comparative experiments. Dupont Superior Panchromatic with which the accompanying illustrations were made has given excellent results, although possibly other films may be found which are better suited to this light.

Equipment for Indoor Work

In preparing the photographic apparatus for indoor use, the camera should be so mounted that the axis of the lens is horizontal, and both the camera and the platform upon which the insect is placed for photographing must be mounted very rigidly in order to eliminate vibration and consequent loss of definition. As the amount of photographic magnification is increased this becomes a serious problem and unless the whole structure is very rigid every nearby truck, train or street car will cause noticeable vibration. Another matter of importance is to support the extension tube at a point near the lens. If this is not done the vibration will be excessive no matter how firm the remainder of the structure may be.

One of the arrangements used by the writer is shown in figure 224. The bed on which the equipment is mounted consists of two 5-ply hard wood panels bolted together and weighing about 40 pounds. Sponge rubber

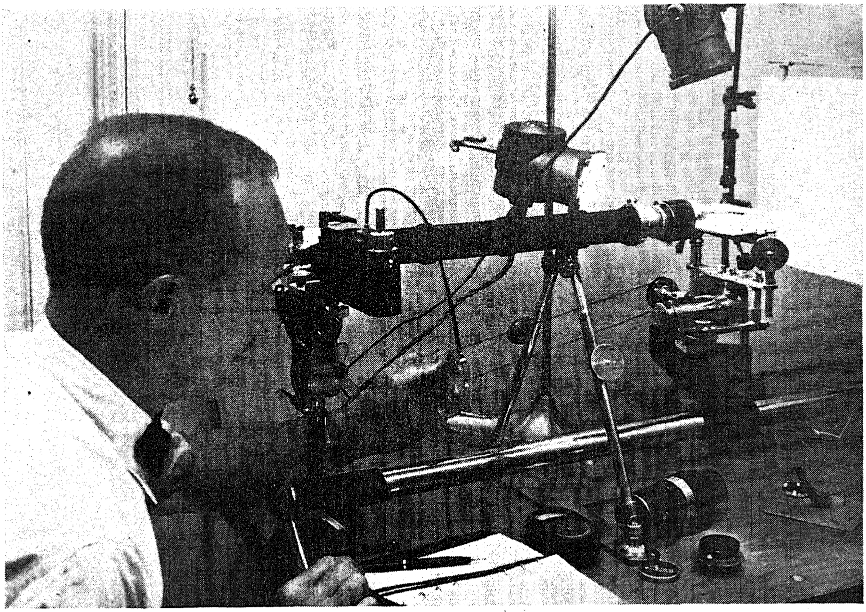


Fig. 224 James M. Leonard and his Camera Equipment for the Photography of Insects

blocks are placed between the panel and the table top to absorb vibration. The table itself rests on cork. The camera is attached to a tripod head from an old German machine gun mount. These can be picked up in some of the stores dealing in second hand war material. The various adjusting screws on the tripod head make it possible to raise or lower the camera, to rotate it from side to side, and to tilt it in any direction.

The mounting bed carries a heavy walled brass tube which is strongly braced and on which are two Leica sliding arms. The outside diameter of the tube is 1¼ inches which is the correct size to fit the sliding arms. A small platform on which the insect is placed for photographing is mounted on one arm and the other is used to support the backgrounds. The platform can be moved forward or back by means of a rack and pinion. A movable support for the end of the extension tube rests on the mounting bed.

Photographing at Home

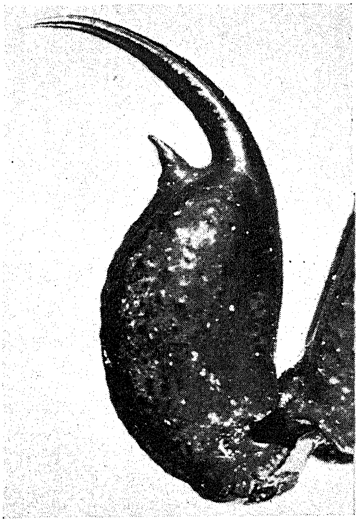
The insect to be photographed is placed on the platform and the sliding arm is moved to get about the proper working distance between the lens and the insect. The fine focusing adjustment is made by means of the rack and pinion.

Having put the insect in place and arranged the lights all that remains to be done is to focus, expose, develop and print. These few operations, however, bring up some very interesting problems. For example, the question of the proper diaphragm opening is a vexing one and usually resolves itself into a compromise between depth of focus and definition. Stopping down the diaphragm increases depth

Fig. 225 *Amblicorypha Oblongifolia*—A Relative of the Katydid

of focus but in the case of some lenses results in a loss of definition. Opening it may increase the resolving power but gives almost no depth of focus. A fairly wide open diaphragm may be permissible when photographing an insect's head or other part which will not include the foreground or the mount on which the insect is placed. If, however, these are included in the picture the result will be far from pleasing. The foreground will show a clean cut section which is in sharp focus while everything in front of and beyond this section will be completely out of focus. As the diaphragm is closed the section in focus will widen and the line of demarcation between it and the out-of-focus area will grow less distinct. The optimum opening is reached when the areas which are in focus and those which are not blend into each other; the important parts of the insect being, of course, in focus.

Some difficulty may be encountered in determining whether or not the insect is sharply focused because of the small amount of light reaching the ground glass when the diaphragm is partially closed or when several sections of extension tube are used. Focusing will be made much easier if the ground glass is given a light coating of oil.



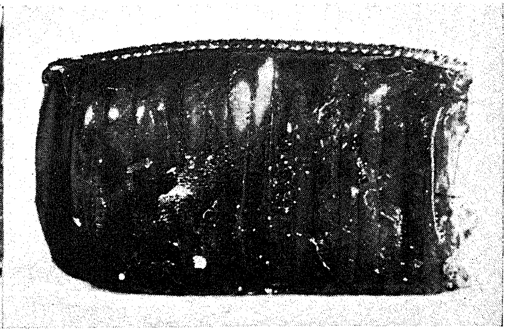


Fig. 226 (*left*) The Poison Sting at the End of a Scorpion's Tail

Fig. 227 The original Zipper Purse—The Egg Case of a Cockroach

Cocoanut oil is very satisfactory for this purpose. Place a drop on the ground side of the glass and spread it with the finger, rubbing lightly in one direction and then at right angles to that direction to insure even distribution of the oil. Do not use cloth to spread the oil because pieces of lint are likely to adhere to the glass. Wipe the surplus oil from the finger after each rubbing in order to reduce the film to the right thickness. The proper amount remains when objects several feet distant appear indistinct when viewed through the glass.

Exposure

The proper length of exposure can best be determined by the trial and error method. An exposure meter will help, but the subject being photographed is so small that the amount of light which it reflects toward the lens is insignificant compared with the light reflected by the mount or the background. About the only way to be sure of getting a usable negative is to make four or five exposures of each subject. The first exposure should be somewhat shorter than the estimated correct time and each succeeding exposure should be 1½ or 2 times the preceding one. A record should be kept of the subject, the lighting used, the length of the extension tube, the diaphragm opening, and the time of each exposure. A study of such a record will soon enable the experimenter to make a sufficiently good guess at the exposure time so that if not more than three exposures are made as just described one of them will produce a negative of the correct density.

The table on page 198 will be very helpful in determining the relative exposure for any length of extension tube and includes other valuable in-

formation as well. Also consult the chapter on Copying and Reproduction, by Willard D. Morgan, for information on other lenses and on depths of focus.

Any reference to films and developers may seem unnecessary. These subjects have been fully covered in many publications. A few personal opinions will be ventured, however, in the hope that they may help the beginner in insect photography. If extreme definition is desired the order of preference probably should be (1) positive film, (2) orthochromatic and (3) panchromatic. If proper rendition of the colors is the first consideration the order should be reversed. Many insects, particularly the moths and butterflies are marked with red or orange and if the various gradations and shades of these colors are to appear in the finished print the use of panchromatic film is essential.

Fig. 228

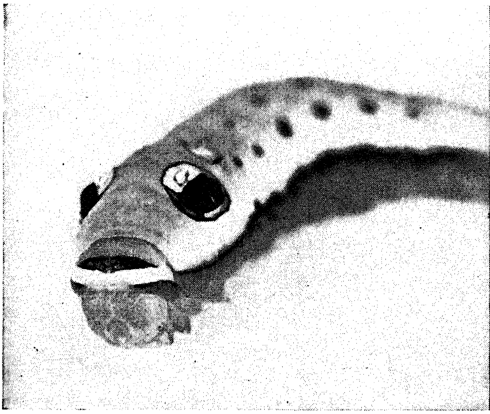
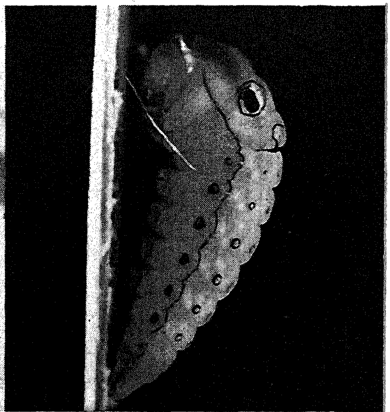


Fig. 229



The Life Cycle of the Spice-bush Swallow-tail Butterfly

Fig. 230

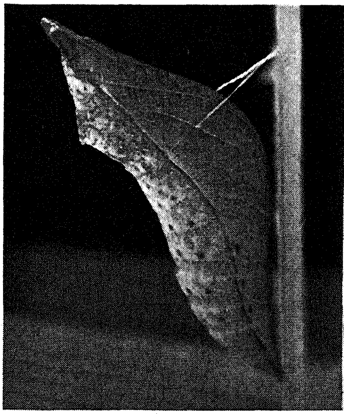
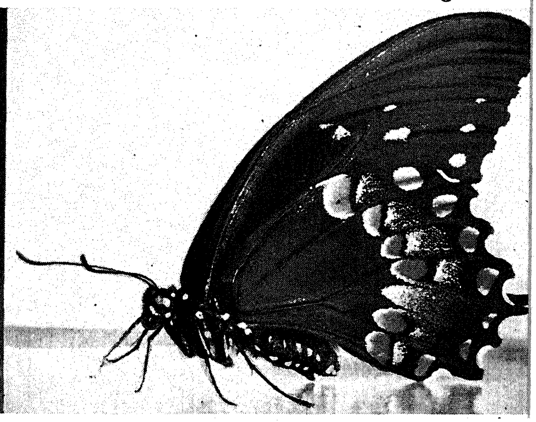


Fig. 231



The writer has adopted DuPont Superior panchromatic film and the so-called Sease No. 3 developer for his own use. The formula for this developer has been published many times but will be repeated here for the sake of completeness.

Sodium Sulfite	**3 oz. 76 grains**	**90 grams**
Paraphenylene Diamine ...	**154 grains**	**10 grams**
Glycin	**93 grains**	**6 grams**
Water	**33 oz.**	**1 liter**

Developer at 68° F.

Gamma in fourteen minutes.....................	0.62
Gamma in twenty-eight minutes.................	1.09
Gamma in forty-two minutes....................	1.34
Time to reach 0.7 gamma.......................	17 minutes

While this developer has the disadvantage of requiring approximately double exposure it has the advantage of excellent keeping qualities and of producing fine grain. The writer has developed twelve rolls of film in a liter over a period of months and the developer still appeared to be in good condition.

It is hoped and believed that those who take up insect photography will find it a fruitful source of enjoyment and relaxation. The use of a little imagination in departing from the usual procedure of photographing the entire insect will produce interesting, and sometimes amusing results. A collection of insect portraits may be made, or individual parts of the insect, rarely seen in detail by the unaided eye, may be photographically enlarged. Figure 225 is a typical insect portrait, the subject, in this case, bearing a surprising resemblance to the head of a horse. Figures 227 and 226, the egg case of a cockroach with its zipper top, and the poison-sting which is the scorpion's weapon of attack, are examples of parts of insects so enlarged that their details may be seen. Caterpillars found in the garden or the field may be brought home to develop their fascinating and mysterious life cycle within reach of the camera. Figures 228 to 231 show four stages in the life cycle of *Papilio-troilus,* the Spice-bush Swallow-tail butterfly. These few suggestions by no means exhaust the possibilities of this interesting branch of photography. The field is limited only by the bounds of imagination.

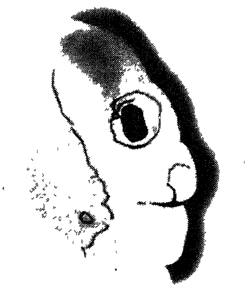


Fig. 232 Portion of Fig. 229. Who is the Father of our Country?...

PHOTOMICROGRAPHY WITH THE LEICA CAMERA

H. W. ZIELER

CHAPTER 19

The Leica camera, the pioneer of miniature cameras has opened so many new fields to photography and has been used successfully for so many different tasks where it replaced larger cameras, that it is not surprising when it enters the field of photomicrography.

It has become well known that for certain types of photography the miniature camera is directly essential, due to special optical conditions which are verified in this kind of camera. The combination of high speed of the objective and depth of focus in the picture which has been thoroughly discussed in the chapter on lenses, establishes the necessity of miniature cameras for many special tasks such as candid photography, photography of small objects, stage photography and others. For these purposes the miniature camera is essential because it does what no larger cameras can do. When trying to use the Leica camera for photomicrography it may appear upon superficial consideration that something paradoxical is being attempted. If small objects are to be photographically reproduced at a high ratio of magnification, it seems necessary to have a large negative, rather than crowding the enlarged detail again into a small negative. The sceptic may readily admit that photomicrography with a miniature camera is not altogether impossible but he may consider it more or less useless or unsatisfactory and, at any rate, not specifically advantageous. It is interesting that a closer investigation of the optical principles proves beyond doubt that for certain types of photomicrography the miniature camera is essential and it is only with its help that some apparently unsurmountable difficulties can be solved.

When to Use the Leica for Photomicrography

In order to fully appreciate why the Leica camera can be used for photomicrography and why it may be the only means towards achieving success, we must again dive into several intricate optical problems.

Some of them have been thoroughly explained in the chapter on Leica lenses and need only short recalling.

To begin with, we must realize that **the very purpose of photomicrography is to record minute detail** which is so small that it must be magnified in order to become visible. In the microscope there are two lens components which participate in the process of magnifying, and in taking the photomicrograph a third factor enters to make the process complete:

1. the microscope objective forms a magnified image of the object under investigation
2. the eyepiece of the microscope remagnifies this image
3. the distance between the eyepiece and the negative on which the picture is recorded determines the area which the magnified image finally occupies in the photograph.

It is interesting and important to know, that **only the first** of these three stages of magnifying is capable of revealing finer detail. The function of the eyepiece and the *projection distance* in recording the image on the negative is comparable to an enlarging process. In the enlargement we find the same detail which was in the negative but stretched over a larger area to bring it within the limit of visibility of the eye. Every single detail which we find in the enlargement was also in the negative, only it may have been so close together that the eye could not see it.

In photomicrography we find all revealable detail in the first magnified image which the objective produces. In this image, however, the detail is crowded into such small space, that considerable enlargement is possible before it is fully detectable by the human eye. We could place the negative in the plane where the objective has formed the first magnified image and simply enlarge this negative with a regular enlarging apparatus. In doing this we would meet with some technical difficulties. In the first place the grain size of the silver deposit in the finished negative would limit us in producing greatly magnified enlargements. And then, as was mentioned in the chapter on lenses, there is always a certain loss of detail in recording the image on the turbid emulsion of the film. The light, in penetrating through this layer, is scattered and thus the rendition of detail is slightly decreased.

Therefore it is advisable to call for the assistance of another optical unit to participate in the process of enlarging the image which the objective has formed. But although we can let the eyepiece carry the

entire burden of the enlarging process so that in the original negative we find the detail separated far enough to make it visible for the eye (in which case a contact print could be made from the negative) we may, with equal justification, divide the task so that for instance in the negative the detail is still four times more crowded than is permissible for the eye to see it. In this case we simply enlarge the negative again four times in our regular enlarger.

The realization is of utmost importance. We must not forget that any process of magnifying is naturally connected with a reduction of the light intensity in a given area. In fact, the light intensity decreases with the square of the size of the negative so that for instance in taking a photomicrograph on a plate of 5 x 7 inches we require an exposure which will be 25 times as long as that which a Leica negative (1 x $1\frac{1}{2}$ in.) requires if it is placed so much closer to the eyepiece, that

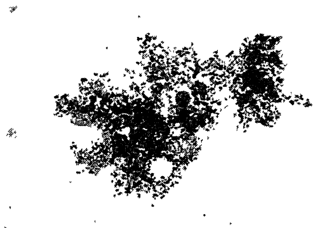


Fig. 233 Amoeba Dubia
10x Objective, 8x Eyepiece

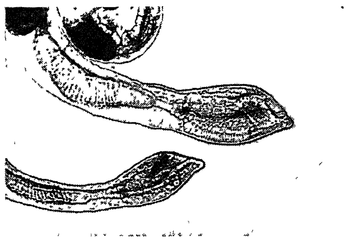


Fig. 234 Chaetogaster
3x Objective, 8x Eyepiece

C. G. Grand

the same area of the object is reproduced on it. There are many occasions where a short time of exposure in a photomicrograph is essential because the specimen under the microscope may be living and moving around so that it can only be photographed by instantaneous exposure. Often it is not possible to increase the intensity of the light by selection of a stronger light source because the enormous concentration of light in the plane of the object may quickly destroy the delicate structure of the specimen. In these cases there is just one solution: the miniature camera. It is not surprising that it was the important field of **photomicrography of living objects** which came to its full practical significance only through the miniature camera.

But, whereas the miniature camera is indispensable for this type of photomicrography, it can also be used with great convenience for many tasks of **general photomicrography** without serious disadvantage. Whenever a great many photomicrographs have to be taken under identical light conditions and magnification, it is, of course, a great convenience to have the Leica with its great film carrying ca-

pacity, its inexpensive negative material and the great variety of film emulsions. General Photomicrography with the Leica is economical and convenient. Only in rare cases will it happen that the requirements for recording even the very minutest detail, are such that the method with the small negative may show slightly inferior results when compared to photomicrographs on larger negatives.

Photomicrography of living objects and general photomicrography are of great importance for the scientist. But also the amateur can become interested in it and he can derive an infinite amount of pleasure from it. So we have a rather popular field of application for the Leica camera in **photomicrography as a hobby.**

To summarize, we can form three groups and this classification is not arbitrary but has quite an important influence upon the selection of the best equipment:

1. Photomicrography of moving objects: the Leica is a necessity,
2. General photomicrography: the Leica is an economical convenience,
3. Photomicrography as a hobby: the Leica is a source of pleasure.

How to Adapt the Leica Camera to the Microscope

In describing the technique of photomicrography with the Leica camera we must, of necessity, give preference to those details which relate specifically to the camera. The problems pertaining primarily to microscopy must be treated more briefly, because we wish to condense the information into a chapter rather than into a library. Therefore we shall, for the present, consider the microscope as one unit, and the Leica camera as another one and then describe the best method of combining these two units for the various purposes of photomicrography.

Among the accessories offered for the Leica camera, there are devices which permit three different ways of adaptation of the camera to the microscope. Which of these three devices should be used, depends again upon the type of work which we want to do.

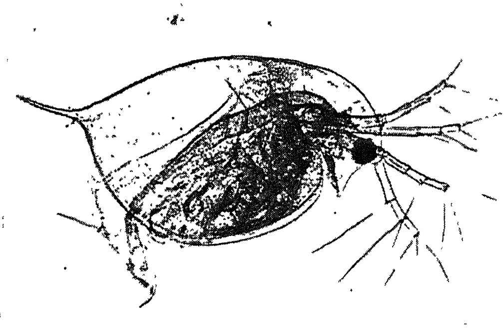


Fig. 235 Daphnia Pulex
C. G. Grand
2x Objective, 8x Eyepiece

Photomicrography of Living Matter with the Micro Ibso Attachment

When using the Micro Ibso attachment, the regular Leica lens must be removed from the camera. That means that this attachment cannot be used with Leica Model A. The attachment, shown in figure 236 is to be adapted to the camera body like a regular Leica lens. At its lower end it is equipped with a microscope eyepiece. This eyepiece has a magnifying power of 10x when used for visual observation. Used in connection with this device, however, this power is not fully developed because the small negative of the Leica camera is placed so close to the eyepiece. The microscopist knows that only if the negative is placed 10 inches from the eyepiece, the magnification of the latter in photomicrography will be equal to that which prevails in visual observation. With the Ibso attachment the eyepiece does only one-third of its performance for visual observation. But this is just enough to spread the detail conveniently over the area of the Leica negative. That means that a Leica negative, enlarged to the size of 3 x 4½ inches will represent a photomicrograph with the same magnification as that which prevailed if the same objective and eyepiece would have been used for visual observation.

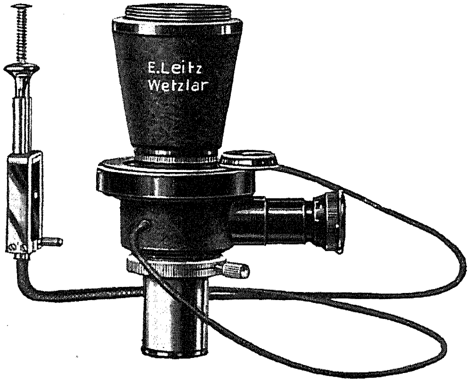


Fig. 236 Micro-Ibso Attachment with synchronized cable releases: one activating the Compur Shutter, the other throwing the prism out of the path of light rays

The eyepiece can be removed from the Ibso attachment by unscrewing the knurled adapter ring with which the entire device is clamped to the microscope tube. It is not advisable to use eyepieces of different magnifying power. It must be realized that the field seen through the microscope is circular whereas the shape of the negative is rectangular. On the other hand we find in photomicrography that it is

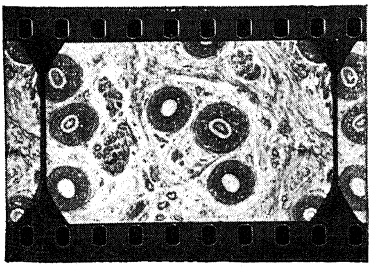


Fig. 237 Leica Photomicrograph made with the Micro-Ibso Attachment

often next to impossible to have the entire field appear uniformly sharp in focus. Especially at higher magnification the outer portion of the field is more or less out of focus. The eyepiece with which the Ibso attachment is equipped has such magnifying power that the most valuable portion of the field is utilized. How the image of the specimen fills the frame of the Leica negative is shown in figure 237.

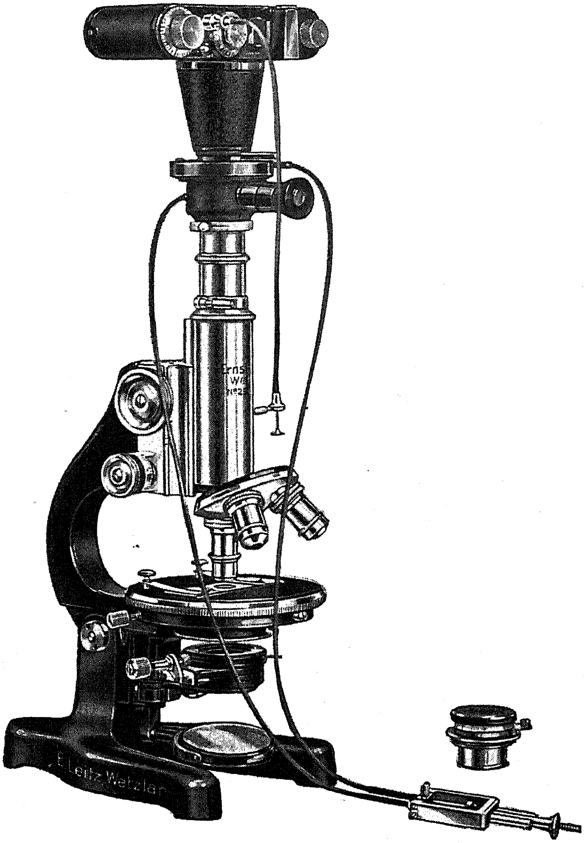


Fig. 238 Micro-Ibso Attachment with Leica camera placed upon Microscope—ready to use

The middle section of the Ibso attachment contains a beam-splitting prism which can be removed from the course of rays by operation of a wire release. So that this prism may also be **held** outside of the course of rays, the wire release is equipped with a clamping screw. A certain portion of the light which has passed through

the microscope is reflected by the prism into a side telescope where the micro image can be visually observed and focused. The balance of the light passes onto the film. Above the telescope there is a Compur shutter with which the actual exposure is made. A conical housing is attached to the middle section and this is of such length that the image will fill the negative as shown before. This housing also contains a lens system for the purpose of correcting the passage of the rays so that at this short distance a sharp image can be produced.

It is the beam-splitting prism and the side telescope which make the Ibso attachment so valuable for photomicrography of living objects. When the specimen is in motion it is essential that we have a method of observing and focusing continuously until the very instant before the exposure is taken and these two features enable us to do so.

And in order to shorten the time of exposure as much as possible we do not only benefit from the small negative size of the Leica but also from the fact that during the (general instantaneous) exposure the beam-splitting prism is removed from the course of rays, thus conveying the entire available amount of light onto the film.

The side telescope is equipped with an adjustable eyelens. This is an important device which is often overlooked. When focusing visually we must realize that there are differences in the eyesight of different observers. When the image appears in focus for one observer, it may not be sharp for another; yet the image must **always** be sharp **in the plane of the film.** These differences are compensated by the adjustable eyelens. In looking through the side telescope a cross hair ruling is visible. Before focusing the microscope the observer must turn the mount of the adjustable eyelens until the cross hairs appear in perfect focus. Only when this is done should the microscope be focused with the coarse and fine adjustment. In this case there will aways be coincidence of focus in the side telescope and in the plane of the film. If a different observer looks through the side telescope and finds the micro image out of focus, the cross hairs will likewise lack in sharpness. But simply by turning the mount of the adjustable eyelens crisp focus can be established for both, the image and the cross hairs.

It may appear strange that a Compur shutter is required to take the photo inasmuch as the Leica camera has a focal plane shutter. This shutter, however, when released, moves in a direction which would create a lateral momentum and cause vibrations which would affect the sharpness of the picture. The Compur shutter avoids this

danger. But since the transporting of the film is coupled with the winding of the Leica shutter, the procedure of taking successive photomicrographs is somewhat complicated and the photomicrographer will have to accustom himself to the following sequence of manipulations.

1. Remove the lens from your Leica camera and adapt in its place the Micro Ibso attachment to the camera body of Leica models C, D, E, F, FF, or G.
2. Remove the regular eyepiece from the microscope tube, set the tube to the correct mechanical tubelength prescribed by the manufacturer (some microscopes are equipped with draw-tubes, others have stationary tubes; the manufacturers have different standards as to the length of the tube and when the microscope is equipped with a draw tube, this must be correctly set) and place a rubber ring or metal clamp around the draw-tube so that the weight of the camera with Ibso attachment will not change the tubelength. A rubber ring is supplied with the Ibso attachment.
3. Adapt the Ibso attachment with Leica camera to the microscope by inserting the eyepiece of this attachment into the microscope tube. Then tighten the clamping screw on the knurled ring at the lower end of the Ibso attachment.
4. Fasten the two wire releases to the Ibso attachment. The one with clamping screw is for the beam-splitting prism, the other one is for the Compur shutter.
5. Attach the regular wire release to the Leica camera. Wind the focal plane shutter of the Leica camera and set it for time exposure.
6. Adjust the eyelens of the side telescope so that the cross hairs appear in sharp focus.
7. Focus the image of the microscope with coarse and fine adjustment while looking through the side telescope.
8. Set the Compur shutter for the correct time of exposure.
9. Press the wire release of the Leica camera and clamp the wire release in this position so that the focal plane shutter will remain open. You are now ready to take the exposure by pressing the wire release of the Compur shutter. If you wish to have as much light as possible for the exposure, you can also swing the beam-splitting prism out of the course of rays. Thus you will have to operate two wire releases simultaneously. But you must also operate the fine adjustment of the microscope continuously and since we have only two hands, you may wish to make use of an automatic release attachment which permits with one motion to swing out the prism and immediately afterwards to take the exposure. This attachment is likewise shown in fig. 238.
10. After the exposure has been taken, loosen the clamping screw of the Leica wire release, thus closing the focal plane shutter. Wind to the next frame, press the Leica release again, clamp it in this position and you are ready for the next picture.

Whereas the Ibso attachment can, of course, be used for every task in photomicrography with the Leica camera, regardless of whether the object is moving or stationary, other devices may be preferred in

the latter case. The Ibso attachment, after all, is not inexpensive and other Leica accessories may be used equally well, having the added advantage of the possibility of other applications.

General Photomicrography with the Sliding Focusing Attachment

Excellent photomicrographs can be taken with the Leica camera adapted to the sliding focusing copy attachment when the latter is attached to the extension arm on the upright of the Valoy enlarger (or other models) and is provided with an extension tube of a certain minimum length. Also in this case, Leica Model A cannot be used because the camera body alone must be attached to the focusing attachment. The general set-up is shown in figure 239. After having removed the lamp housing from the upright of the enlarger, the spe-

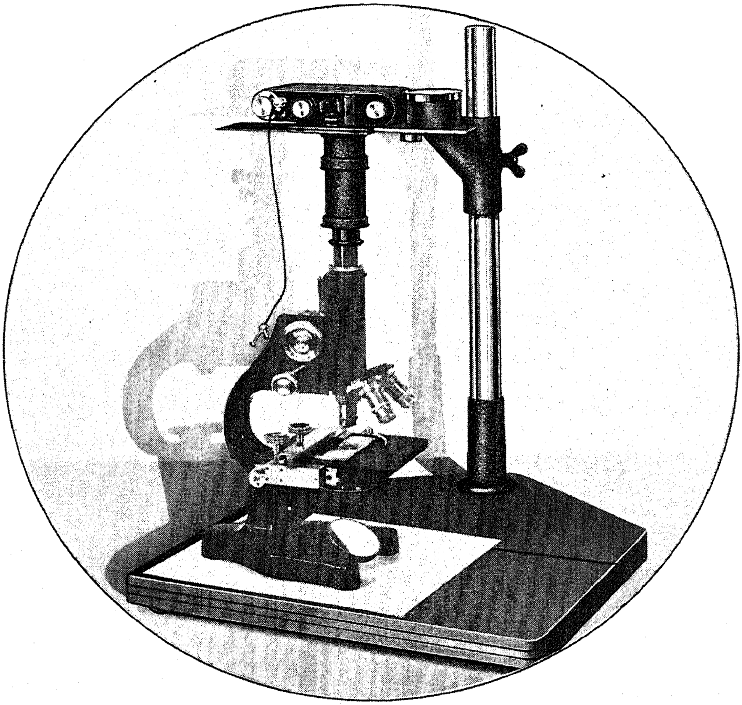


Fig. 239 General set-up showing how a Sliding Focusing Attachment is used with the Leica for Photomicrographic work.

cial arm which holds the focusing attachment with the Leica camera is fastened to the upright. An extension-tube of 6cm. should be used attached to the sliding focusing attachment. The arm carrying the entire Leica equipment is lowered until microscope tube and extension

tube just overlap. A light-proof connection can easily be established by wrapping a piece of black paper or cloth around the lower end of the extension tube.

It is, of course, possible to use extension tubes of any length. The total length of the tubes used will determine the magnification of the image in the plane of the film and therefore also the area which the image occupies. A tube of 6cm. has been suggested for definite reasons. When this tube is used, the image will occupy about the same area as that shown in fig. 237, when an eyepiece of 10x magnification is used, as in the case of the Ibso attachment. It is also possible to use eyepieces of different magnifying power. When these eyepieces are used for such short projection distances they do not yield their total magnifying power which would prevail in visual observation. Only if the total distance from the rim of the eyepiece to the plane of the film is 10 inches will the eyepiece yield the same magnifying power as in visual observation. For shorter distances this power decreases correspondingly. When the total distance is only about 3 1/3 inches (as it will be when thc 6cm tube is used) the eyepiece magnification is also reduced to 1/3 of its full value, which corresponds to that which we use when taking photomicrographs with the Ibso attachment.

For those who want to proceed in strictest accordance with correct optical principles it may be mentioned that when taking photomicrographs with the focusing attachment, they may use eyepieces with adjustable eyelenses to compensate for the short projection distance. The principle involved is too complicated and the benefit derived too minute to require special explanation. The reader who is interested is referred to literature about microscopy.

The procedure in taking photomicrographs with this equipment is as follows:

1. Before placing the focusing attachment with Leica camera and extension tube in position, focus the microscope roughly for visual observation so that the microscope tube will not have to be displaced too much in vertical direction after the light-proof connection has been established.
2. When the microscope has been focused visually, lower the arm on the upright until the extension tube overlaps the microscope tube and make the light-proof connection. Tighten the clamping screw on the extension arm when the image on the ground glass appears as shown in figure 2 (provided a 10x eyepiece and 6cm tube were used).
3. Attach the wire release to the Leica camera.
4. Focus the image sharply on the ground glass by means of the fine adjustment of the microscope and slide the Leica camera into position. You are now ready to take the photomicrograph.

When the focal plane shutter is released there is no danger of vibrations affecting the sharpness because the Leica camera is held rigidly in the focusing attachment.

Obtaining Critical Focus

Critical microscopists may resort to a simple trick in order to avoid any error in focusing on the ground glass. A small piece of thin clear glass, such as a cover glass, used for protection of micro slides, may be pasted to the ground glass with a small droplet of cedar wood oil. The covered area will become transparent and the aerial image may be focused with a special 30x magnifier (a special ground glass with a clear strip and calibrated scale is also available). This magnifier, however, must also be focused to the plane of the coverglass. Therefore, before attaching the coverslip, a small pencil mark should be made on the ground glass. The magnifier may be raised or lowered in its mount until this pencil mark appears in sharp focus. Then the fine adjustment of the microscope must be operated until the micro image also appears in sharp focus.

The results which can be obtained with this equipment are so satisfactory that for many purposes of general photomicrography it finds more and more extensive use. As long as stationary objects are to be photographed it is often preferred to the Ibso attachment because it seems easier to obtain a critical focus although with some training the other method yields equivalent results.

There is another method of photomicrography with the Leica camera which requires less equipment. This method may be suggested to the amateur who may not wish to go too deeply into this type of work.

Amateur Photomicrography with the Micro Adapter Ring

When using the Leica camera with the micro adapter ring the lens must be left in the camera. Therefore it is also possible to use Leica Model A for this type of photomicrography. The micro adapter ring is slipped over the tube of the microscope and its upper part is so shaped that it can be adapted to the rim of the Leica lenses of 50mm focal length like a light filter.

The method of focusing is as simple as it is interesting. Focus the microscope for visual observation, focus the Leica camera independently for infinity and then place it over the microscope into the micro adapter ring where it is held in place by tightening the clamping screw in the upper part of the adapter.

This method of focusing is so interesting because it reminds us of the fact that the human eye is really a very small miniature camera, perhaps the most remarkable miniature camera in existence. The

human eye is equipped with a lens which forms images on the retina. But this lens has no focusing mount and yet it can be focused. It is certainly a most wonderful creation. Since nature preferred not to provide our eyes with bellows or focusing mounts which would permit to change the distance between the lens and the retina, **the lens in the human eye focuses itself automatically by changing its focal length according to the distance from which we look at the object.** When this distance is small, the lens increases its curvature (controlled by a most ingenious mechanism of muscles) to shorten its focal length until the image is sharp on the retina. If the object is farther away the muscles relax and decrease the curvature to increase the focal length just enough to have again a sharp image on the retina. And this complicated mechanism works so perfectly that we operate it unconsciously and instantaneously as soon as we open our eyes.

Nevertheless it is a strain for the eye when it looks at an object at close distance whereas it relaxes as much as possible when it looks at an object which is infinitely far away. And since the microscopist must often look through the instrument for long periods at a time the scientists designed the optical equipment of microscopes so that the **eye can be as much at ease as possible.** In other words **the lens in the eye focuses itself as if it would have to look at an object at infinity.** And if we replace the human eye by another miniature camera (or, for that matter, by any photographic camera, regardless of size) the lens of this camera must likewise be focused to infinity.

Not every observer has perfect eyesight. Some are near sighted others are far sighted. That means that their focusing mechanism is out of order. Such defects may happen to the focusing mechanism of other miniature cameras. But as long as we deal with manufactured cameras we can send them to the manufacturer for readjustment. He can determine the amount of the error and can either place an intermediate ring under the objective mount or he can shorten this mount until the images are always in focus if we operate the focusing mechanism with the rangefinder. Unfortunately there are no similar repair shops for our eyes so that we must content ourselves with a correction of the discrepancy by adding front lenses which we call *spectacles,* to the lens of the eye. **And everybody who must wear eyeglasses for correction of defects of his eyelenses, should always leave them on when focusing the microscope visually before taking pictures with the Leica and Micro Adapter Ring.**

Before adding the weight of the Leica camera with adapter ring to the microscope it is also advisable to attach a rubber ring or a metal clamp to the draw tube of the microscope at the correct length.

The distance between the Leica camera and the microscope is now so small that the magnifying power of the eyepiece is still further reduced to only one-fifth of its power for visual observation. In other words, if the Leica negative is enlarged five diameters the final print will represent a photomicrograph which has the same magnification which would have prevailed in visual observation with the same objective and eyepiece. Figure 241 shows the relation between the Leica negative and the area covered when taking a photomicrograph with the micro adapter ring, using an eyepiece of 12x magnification. Eyepieces of different magnifying power can also be used, but sometimes it will be difficult to avoid internal reflections within the optical system.

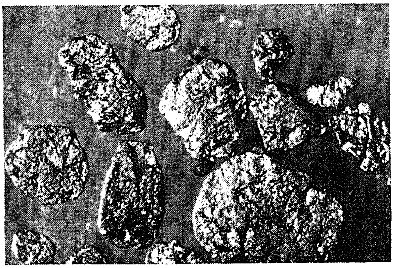


Fig. 240 Placer Gold. Photomicrograph by R. E. Head, made with Ultropak and Leica

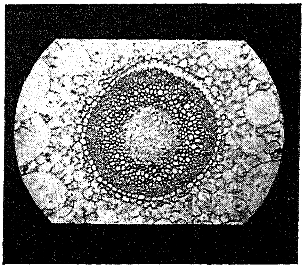


Fig. 241 Leica used with Micro Adapter Ring and 12x Eyepiece covers area shown

The procedure of taking photomicrographs with the Micro Adapter Ring can be summarized as follows:

1. Set the draw tube of the microscope to the correct length and fasten a rubber ring or metal clamp so that this tube length will be maintained when the Leica camera is placed into the Micro Adapter Ring.
2. Detach the black lacquered upper part of the Micro Adapter Ring from the lower metal part, withdraw the eyepiece from the microscope tube, fasten the lower part of the ring to the tube and tighten the clamping screw.
3. Insert the eyepiece into the microscope tube and attach the upper part of the Micro Adapter Ring.
4. Focus the microscope for visual observation.
5. Focus the Leica camera independently for infinity. Attach the wire release and wind the shutter which must subsequently be set for the correct time of exposure.
6. Attach the Leica camera carefully to the upper part of the Micro Adapter Ring and tighten the upper clamping screw. You are now ready to take the photomicrograph.

Those who possess an enlarger and an extension arm may prefer to attach the Leica camera to this arm, place the microscope with the adapter ring on the baseplate of the enlarger and lower the arm until the Leica lens mount connects with the upper part of the Micro Adapter Ring. Thus the weight of the Leica camera does not rest on the microscope. This has not only the advantage of avoiding the danger of vibrations when releasing the shutter but also that of affecting the accurate focus, especially at high magnifications.

This method of photomicrography with the Leica camera, incidentally is optically the most correct one because the microscope retains the same focus as for visual observation and the correction of the entire optical system of the microscope is at its best under these conditions.

How to Select the Microscope For Photomicrography of Living Matter

Whereas prepared microscopic specimens are generally mounted on glass slides as thin sections and can be observed by sending light **through** them, living organisms or unprepared objects are mostly more or less opaque and of irregular shape. They not only require a microscope stand of special design but also special illumination arrangements. These illumination devices also influence the design of the microscope.

As long as these opaque objects are to be photographed at low magnification the illumination offers no difficulties. Under these conditions the distance between the front lens of the microscope objective and the object is comparatively long. (This distance is generally called *working distance,* a term which should not be confused with the focal length of the objective). The light emitted by a suitable microscope lamp may be concentrated by a so-called *bull's eye condenser* and may be so guided that it falls obliquely upon the surface of the specimen. But as the magnification increases the working distance decreases so rapidly that even at moderately high magnification there is not enough clearance between objective and specimen to *squeeze* the light between the two.

Microscopists who examine the surface structures of metals use a device known as *vertical illuminator.* It is attached to the lower end of the tube. The light, entering laterally, is reflected into the direction of the *optical axis* of the microscope and passes through the objective which simultaneously acts as a condenser, to concentrate the light in the plane of the object. From the surface of the object the light is reflected and passes again through the objective which now acts as an image forming unit.

This method of illumination, which yields satisfactory images of the highly reflecting polished and plane surfaces of metals, fails if

applied to the illumination of rough low reflecting and uneven surfaces of organisms or other materials. As the light passes through the objective on its way to the specimen, partial reflections occur at the surfaces of the different lenses which produce a haze thus greatly reducing the contrast in the image. This haze may even obliterate the detail completely.

The situation can be compared with one which you undoubtedly have often observed: a picture hanging on the wall may be covered with a glass plate. Under certain light conditions the glare produced through reflections of light by the glass plate may be so strong that you cannot see the picture at all.

Another illumination method was developed for observation of objects of low reflecting power which avoids the double passage of light through the objective and can be used even at the highest magnifications. The device used for this purpose, the Leitz *Ultropak,* was introduced only a few years ago and it has pioneered this important and utterly fascinating field of microscopic observation and photomicrography of opaque objects with surfaces of low reflecting power at high magnification. The illuminator is shown in figure 242. The light, entering horizontally, is reflected by a ring-shaped mirror and passes through a condenser system which surrounds the objective. This condenser collects the light so that it illuminates the object with highly oblique rays. From the rough surfaces of the object the light is diffusely reflected, passes through the objective, a central hole in the ring-shaped mirror and forms the image.

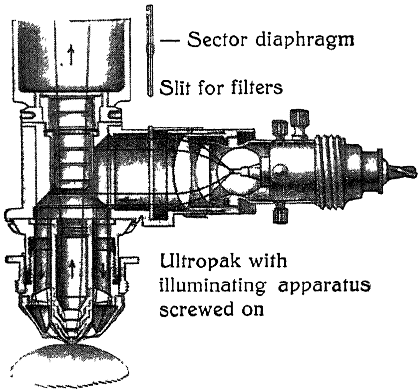


Fig. 242 Diagram showing path of rays of Ultropak

The Ultropak is attachable to every standard microscope tube. It is equipped with a small incandescent lamp which is satisfactory for visual observation but not strong enough for instantaneous photomicrography. In such cases a more powerful light source such as an arc lamp must be used. A special lens system can be attached to the light entrance tube of the Ultropak to concentrate this light. The complete equipment assembled for photomicrography with the Ibso attachment is shown in figure 243.

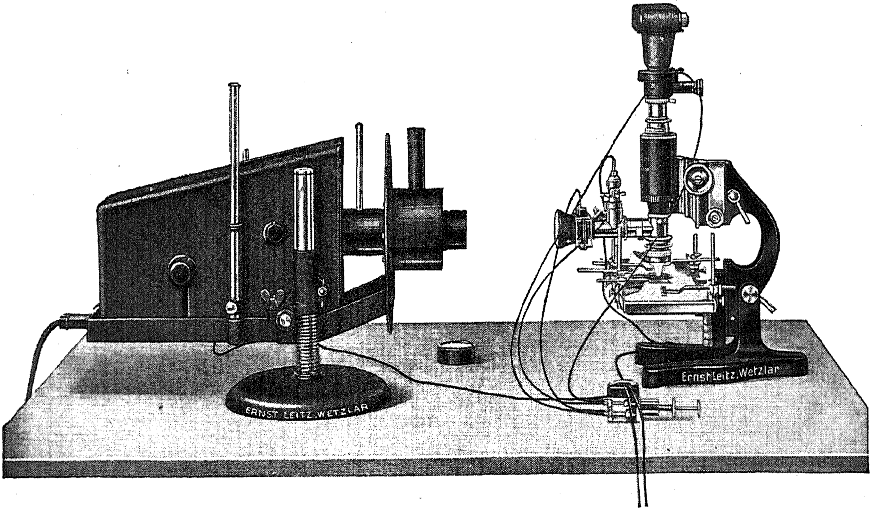


Fig. 243 Micro-Ibso Attachment with Microscope and Arc Lamp for Photomicrography of living matter

This arrangement makes a special type of microscope almost imperative. Generally a microscope is focused by raising or lowering the tube which, for this purpose, is equipped with a coarse adjustment by rack and pinion and a fine adjustment by micrometer screw. The arc lamp, however, not being attached to the tube, would not follow these focusing motions and the horizontal beam would not always pass through the condenser lens which is attached to the Ultropak. In other words, the operation of focusing the microscope would throw the illumination system out of alignment. This difficulty can be overcome by using a type of microscope where **the coarse focusing is done by raising or lowering the object stage.**

Microscopes of this type provide for much space between the tube and the stage so that even comparatively large objects may be placed on the stage in their entirety. These models are recommended for

photomicrography of objects which make the method of illumination by Ultropak or vertical illuminator necessary. They are of such design that substage illuminators for photomicrography by transmitted light can be attached to them.

For General Photomicrography

As mentioned before, specimens which have been specially prepared for microscopic observation are generally mounted as thin sections on glass slides and they are illuminated by sending the light through the thin layer of the object. The structures may allow only certain colors of the light to pass through, whereas others are absorbed. These structures will become visible in those colors which could pass through them. It may be that other structures absorb all colors equally, either completely or partly, and those structures will appear black or any shade of gray against the lighter background. In other words, the structures become visible because of partial transmission of light and the illumination method for these objects is generally called *by transmitted light.* The variety of microscopes available for this type of work is considerable. Essentially all models are built on the same principle although the various features may differ in regard to completeness or design. They consist of an illumination apparatus which guides the light through the object, a stage plate to support the object and an observation system with focusing facilities.

For the selection of a microscope which is to be used for photomicrography a few hints may be of value:

The Illumination Apparatus

The mirror which guides the light from its source through the condenser should have one plane and one concave surface. The condenser should be of the divisible type so that the front lens can be removed when taking photos at low magnification. The illumination apparatus should be equipped with an iris diaphragm to regulate the intensity of the light. There should be a rack and pinion movement to raise or lower the condenser. It is also advisable to have the condenser mounted in a centering adapter. When the photomicrographs are taken at high magnification and microscope lamps with concentrated filaments are used for this purpose, a centering adapter is of essential importance.

Object Stage

It is convenient, though not essential to have a device for the mechanical displacement of the specimen. Such devices are known as mechanical stages. They can be obtained either separately or built into the object stage.

Observation System

It has become general practice to classify the ranges of magnification as follows:

low power (requiring objectives from 40 to 16mm focal length)
medium power (requiring objectives from 10-4mm focal length)
high power (requiring objectives of less than 4mm focal length).

For high power microscopy a type of objective is used which is known as *immersion system.* Regarding further details about objectives the reader is referred to the current literature of microscope manufacturers.

The microscope may be equipped with a revolving nosepiece accommodating either two, three or four objectives. The objectives of 16mm and 4mm are most popular. For higher magnifications oil immersions of about 2mm are generally used whereas for the lowest magnifications objectives of 40mm, 32mm, 24mm or thereabout are almost equally popular.

Contrary to general opinion it is **not** necessary that a microscope for photomicrography be equipped with a tube of large diameter. A wide tube may only be of advantage if it is intended to use a microscope for that type of photography (not photomicrography) which the Leica user can do with the sliding focusing attachment and the regular Leica lenses. In this type of work an eyepiece is not required.

It may also be mentioned that it is not advantageous to take **photomicrographs** without the eyepiece. Sometimes one meets with the erroneous opinion that under such conditions sharper images can be obtained. This is not true. The apparently greater sharpness is simply due to the lower magnification. Actually such pictures lack in sharpness because the objective is not used at the correct tube-length and thus a certain amount of spherical aberration is introduced.

As to the magnification of the ocular, it has been mentioned before that for general purposes an eyepiece of 10x magnification is most satisfactory. Variation of magnification in the final print can always be obtained by varying the ratio of enlargement of the negative. Only in the case of photomicrography with the micro adapter ring an eyepiece of 12x magnification may be recommended.

For Amateur Photomicrography

The rules given for the selection of a microscope for general photomicrography or that of living object can likewise be applied to amateur work. Only in this latter case a simpler microscope will often be fully satisfactory. In this case it is best to see what the manufacturer has to offer.

Magnification and Resolving Power

It was explained at the beginning of this chapter that the objective of the microscope alone is responsible for the revelation of minute detail and that the eyepiece simply stretches this detail to occupy a larger area. The power of the objective to reveal detail is called *resolving power and is limited.* It is possible to determine for each objective the magnitude of the finest detail which it is capable of revealing. And since we can also determine the total magnification

of the image in the negative, we are able to find out how much space the smallest revealable detail will occupy in the plane of the negative. This information is important because, as we know from the chapter about Leica lenses, the human eye can only distinguish detail if it is at least 1/100th inch apart (provided we refer to detail in a photograph which we view from a distance of 10 inches). Thus we will finally be able to answer the question: How much can we enlarge the negative of a photomicrograph taken with the Leica camera without creating the impression that the enlargement will lack in sharpness?

The maximum resolving power of the objective can easily be expressed quantitatively by the magnitude of the smallest detail which the objective can *resolve.* But in practical photomicrography this maximum resolving power can seldom if ever be verified, because it requires certain optical conditions for the illumination of the object which are detrimental in other respects. Therefore in practice the obtainable resolving power will mostly remain below this maximum value.

In the books about microscopy we find that the resolving power depends upon the light collecting power of the objective and the wavelength of the light with which the specimen is illuminated. The light collecting power is generally expressed by a term *numerical aperture.* Its meaning is not identical to the *relative aperture* or *speed* of a photographic lens, but has close relation to it. We need not go into detail about the correct interpretation of the term *numerical aperture* because its actual magnitude is generally engraved upon the mount of the objective and is also listed in the catalogs of the manufacturers. We only have to realize that **the higher the numerical aperture of an objective, the better is its resolving power.**

As to the wavelength of the light, we know that in the spectrum of visible light, the colors towards the violet end of this *rainbow* have the shortest wavelength. But whether we can use these rays for the illumination of the object, depends entirely upon the colors of its structures. Further information about the color of the light to illuminate the object can be obtained in publications regarding the application of light filters for photomicrography. For the present we must only realize that the relation between the resolving power and wavelength of the light is such that **an objective of a certain aperture will yield the best resolving power if the wavelength of the light which illuminates the object is as short as possible.**

But there is a third factor which influences the resolving power and which is often neglected in consideration. It refers to the direction of the light which illuminates the object. As you know, the intensity of the light which passes through a **photographic lens** is regulated by opening or closing the iris diaphragm with which these lenses are equipped. In a microscopic objective there is no iris diaphragm. But we find this iris in the substage of the microscope, directly below the condenser. If we close this iris diaphragm the object will be illuminated only with a small central beam of light. By opening it, the intensity of the illumination increases. But at the same time the resolving power of the objective also increases.

Still, the resolving power may be increased without opening the iris diaphragm. We only have to displace it laterally so that the small beam which illuminates the specimen will not pass through it centrally, that means, in the direction of the optical axis, but obliquely.

When to increase the resolving power by opening the iris and when to displace the iris laterally depends entirely upon the nature of the structures of the specimen and upon the quality of the objective. An objective of good quality can be used with the iris diaphragm comparatively far open whereas in an objective of inferior quality those misbehaviors of light about which we learned in the chapter on lenses will make themselves felt too much.

By opening the iris diaphragm we render the illumination more diffuse and there may be detail which with such illumination will be obliterated. The surface of a piece of paper may appear smooth in diffuse light, but hold it in the beam of a powerful searchlight so that the direction of this light meets the paper surface at grazing incidence, very obliquely. Every little unevenness in the surface will throw a deep shadow and the little *hills and valleys* will appear most strikingly.

These few remarks should indicate that the method of illumination has a great influence, not only upon the visibility of detail which may be so small that the highest possible resolving power is necessary to reveal it, but also because this detail may be of such shape or nature that special tricks must be applied to render them visible even if they are large enough to require only little resolving power.

To summarize we may say that under normal conditions the iris diaphragm of the substage should rarely be opened more than 1/4 to 1/2 of its greatest opening and as to the color of the light we shall learn presently why a green filter will find most frequent application. Under such conditions it is safe to assume that the magnification re-

quired to separate the detail until it is about 1/100th inch apart, is about equal to 600 times the value of the numerical aperture of the objective used.

From the catalogs of the manufacturers we learn the initial magnifications and numerical apertures of the current objectives. We know that the eyepiece 10x yields about 1/3 of its full magnifying power when used with the Leica camera as described before and with this information on hand we can determine how much the Leica negative of a photomicrograph can be magnified without losing the aspect of a sharp picture. The following table contains these values for some of the most popular objectives and may be of help in photomicrography.

This table has been prepared for Leitz objectives but by comparing the figures for focal length, initial magnification and numerical aperture with those constants of the objectives of other manufacturers it will become evident that the figures can be helpful also to users of other objectives.

Type of objective	Focal length	Initial Magnification of objective	Numerical Aperture	Magnification on Leica negative	Enlargement possible to separate detail 1/100″
Achromat (dry)	40mm	3.2x	0.08	10.5x	4.6 x
"	32mm	4.3x	0.15	14.3x	6.3 x
"	24mm	6 x	0.20	20.0x	6.0 x
"	16mm	10 x	0.25	33 x	4.5 x
Apochromat (dry)	16mm	12 x	0.30	40 x	4.5 x
Achromat (dry)	13mm	14 x	0.40	46.5x	5.1 x
"	9mm	20 x	0.45	66 x	4.1 x
Apochromat (dry)	8mm	23 x	0.65	71.5x	5.5 x
Achromat (dry)	4mm	45 x	0.85	150 x	3.4 x
Apochromat (dry)	4mm	46 x	0.95	153 x	3.8 x
Apochromat (oil immersion)	3mm	65 x	1.32	216 x	3.66x
Achromat (oil immersion)	2mm	100 x	1.30	333 x	2.35x
Apochromat (oil immersion)	2mm	92 x	1.32	306 x	2.6 x
"	2mm	92 x	1.40	306 x	2.75x

Thus we should conclude our chapter on photomicrography because the problems pertaining specifically to the miniature camera have been covered. But there are so many questions pertaining to

microscopy which the miniature camera owner would like to have answered that at least some of them shall be briefly discussed.

Light Sources

It is difficult to recommend one definite light source because so many different types are suitable and yet each of them has special advantages, depending upon the work which has to be done.

For photomicrography of living objects, for instance, a great deal of light is required because the image is formed only by that small portion which is reflected from the surfaces of the object. The effective intensity of light sources for microscopy, however, is not measured in terms of total candlepower and it is very important for the microscopist to understand why we need another measure. Actually we can compare the power of microscope lamps only in regard to their intrinsic intensities. This will become evident if we compare a lamp for 110 volts and 550 watts with one for 6 volts and 30 watts. The only difference is to be found in the length of the filament, that of the lamp for 110 volts being about 18 times as long as that of the lamp for 6 volts. In both cases, however, the filament is fed by a current of 5 amperes and pieces of equal length of the two filaments emit the same amounts of light. Of course with the 110 volt lamp we could illuminate an area having 18 times the square contents of that which, with the same condenser system the 6 volt lamp will illuminate. But the condenser systems are designed for rather small light emitting units because it happens that among these we find the light sources of greatest intrinsic intensity.

Of the two light sources mentioned above the one for 6 volts should of course be preferred because, although it offers the same intrinsic and therefore effective intensity, it consumes only 1/18th of the amount of energy. The fact that these lamps must be used with a transformer (or a rheostat, if d. c. is available) should not be considered as a disadvantage because the lamp fulfills an optical purpose and its performance in this respect is the only important thing.

The intrinsic intensity of a light source increases in proportion to the temperature of the light emitting area. A filament, heated to incandescence can never become as hot as, for instance the crater of an arc lamp where the carbon is heated beyond the point of incandescence so that it is actually consumed Arc lamps have a comparatively small sized crater and in order to enable the miscroscopist to take full advantage of this important type of lamp, the condenser systems of microscopes are so arranged that this small light emitting unit will illuminate the entire field under observation. These are

lamps are often the only type of light source which will make instantaneous photomicrography of opaque living objects possible, even with the small Leica.

For photomicrography in transmitted light we may not require these strong light sources. In the first place, the entire amount of light which is concentrated by the condenser, passes through the microscope and is only partly absorbed by the structures of the object which in the photograph will appear darker than the background. Furthermore, these objects are generally not moving and longer exposures are permissible. In these cases a regular desk lamp with an inside frosted bulb, possibly a photoflood bulb, will give satisfactory illumination. Clear glass bulbs, showing the filament, should not be used, unless a ground glass is interposed.

It is not possible to explain here, how, for every magnification, uniform illumination can be obtained. The reader must try to obtain such information from microscope manufacturers or text books. He will find, that by following definite rules he can avoid the rather uncertain method of trial and error, but these methods would require too much space in this chapter.

Light Filters

The application of light filters in photomicrography is another problem which requires thorough study. The reader is referred to current literature. The Eastman Kodak Co. published a booklet, entitled "Photomicrography" from which valuable information can be derived.

In the vast majority of cases where stained preparations are to be photographed, a green filter, such as the Wratten B filter will be of great help. Not only are most of the stains, used in practice, of such color that a green filter will produce the best contrast and differentiation, but the light transmitted by this filter is of that range of wavelengths for which the correction of microscope objectives is most favorable.

As to the best place to insert the filter, no special advice is necessary since it can be inserted at any place between the lamp and the microscope. It may happen however, that the filter is at a place where any dust spots or impurities on its surface would show in the field under observation because the condenser may form an image of the filter in the plane of the object. If such dark spots are visible, it is easy to find out whether they are produced by the filter or by impurities on the lenses of the eyepiece. Suppose we move the filter laterally and the spots follow the motion, they are caused by dust on

the surface of the filter. But if, upon rotation of the eyepiece in the microscope tube, the spots follow this rotation, they are due to impurities on the lenses of the ocular. In both cases, the surfaces should be cleaned, but if the filter gave the cause, it can also be moved closer to the condenser.

Films

In photomicrography it is often not necessary and even detrimental to use panchromatic film of high sensitiveness. The panchromatism of the film is not required when a green filter is used. As you know, the only difference between orthochromatic and panchromatic film lies in fact that the latter is **also** sensitive to red light. But if the filter has prevented all red light from passing through the microscope, this extra sensitiveness is of no value. On the other hand, panchromatic films are generally less sensitive for green light (that is why green safelights can be used in the darkroom for their development) so that their general high speed does not exist for that range of light color which is transmitted by the filter.

Finally we must realize that these superspeed films really do not yield that same fine detail which we obtain with slower films. It is true that the development can hold the grain size down but for reasons which are too involved to permit explanation at this place, it is really true that the slower films with inherently finer grain produce finer detail.

To sum up, any modern orthochromatic film is perhaps most suitable for photomicrography. Where speed is essential, the faster emulsions are to be preferred, where detail rendition is of primary importance, the slower emulsions are better. Only in cases where living objects are photographed with the Ultropak or a darkfield condenser and if in these cases no filter is used, a fast panchromatic film will have its place.

In exceptional cases positive film may be used. But we must not forget that this film is not sensitive to green light. Used when the Wratten B filter has been interposed in the course of rays, a photomicrograph on positive film would only yield a blank space. Without a filter, the positive film in itself will perform what a blue filter would have done with orthochromatic film. This fact may be helpful in photomicrography of diatoms where the utmost in detail rendition is aimed for. But this task is perhaps one of the very few, where the miniature camera actually does not offer anything but disadvantages over the larger size cameras.

Exposure

Help in gauging the exposure for a photomicrograph is perhaps most urgently needed and it is unfortunate that just in this respect it can hardly be given. The exposure depends upon too many different factors. There is the intrinsic intensity of the lamp, the size of the filament, the opening of the iris diaphragm in the substage, the magnification of objective and eyepiece, the numerical aperture of the objective, the color of the light filter, the density of the specimen, the sensitiveness of the film to the color which the filter transmits and there are many other factors.

The best way out of the difficulty is to take test photos under standard conditions, varying the actual time of exposure. After development of a test film and if the exact data for each exposure have been recorded, the correct time can easily be determined.

Place the light source at a definite distance from the microscope, select the filter, record the position of the iris diaphragm in the substage of the microscope, the magnification and numerical aperture of the objective, the color and density of the specimen, the magnifying power of the eyepiece, the type of film used and then take several exposures, varying the time in wide limits. You can easily find the best negative. Now maintain these standard conditions for this objective and only if a specimen of great density is under observation, lengthen the exposure. Of course, if a different filter is used, new tests have to be made, unless you know the relative filter factor for the particular film brand used.

This standardization will undoubtedly be the shortest way to success and since a microscope equipment will generally not contain more than three or four objectives and, at the most two or three filters, the work involved is really negligible, not to speak of the value of having gone through an experience of this type.

Fig. 244 Dental Operating Room of A. Laurence Dunn, D. D. S., Santa Barbara, California. Photographed by J. Walter Collinge
(Dr. Dunn is left-handed and the equipment is arranged accordingly)

DENTAL PHOTOGRAPHY

A. LAURENCE DUNN, D.D.S. **CHAPTER 20**

Dentistry offers one of the finest fields for the Leica camera in scientific work. With it the general practitioner, the specialist, and the research worker alike will find the opportunity to make records of a remarkable quality.

To show the many uses in dentistry and in photography of all small objects, and to explain how the pictures may be obtained with a minimum of trouble, a simplified yet highly efficient technique is being offered. The work is divided into three sections dealing first with the equipment necessary, second the photography itself, and third a system of records.

Equipment Required

1. Leica camera of any of the later models, and one of the 50 mm lenses such as the Elmar f:3.5, Hektor f:2.5, or Summar f:2 and a cable release.
2. Fuldy sliding focusing copy attachment.
3. Camera support and reflecting board.
4. Magnifying viewer.
5. Two extension tubes, 12mm and 22mm.
6. Photoflood lamp in reflector.
7. Leicameter.
8. Yard stick.
9. Cardboard backgrounds (black, gray, white, etc.).
10. Record pad and pencil.

One piece of apparatus that greatly simplifies photography at the dental chair is the camera support, a home-made device. The one shown in figure 245 may serve as a suggestion of what can be constructed to meet individual needs. Roughly, it consists of a pipe welded onto an old automobile flywheel. Being mounted on casters, it is moved easily, yet stays in position solidly. It is rolled in place by hand and minor adjustments for position are made by foot, with one foot on the base.

As the photograph shows, the apparatus is adjustable for every height and position. The horizontal arm can slide freely on the upright pipe and is controlled by a thumb screw.

To overcome vibration there are three upright rods welded both to the flywheel and the upright pipe. The reflecting board is made of an aluminum

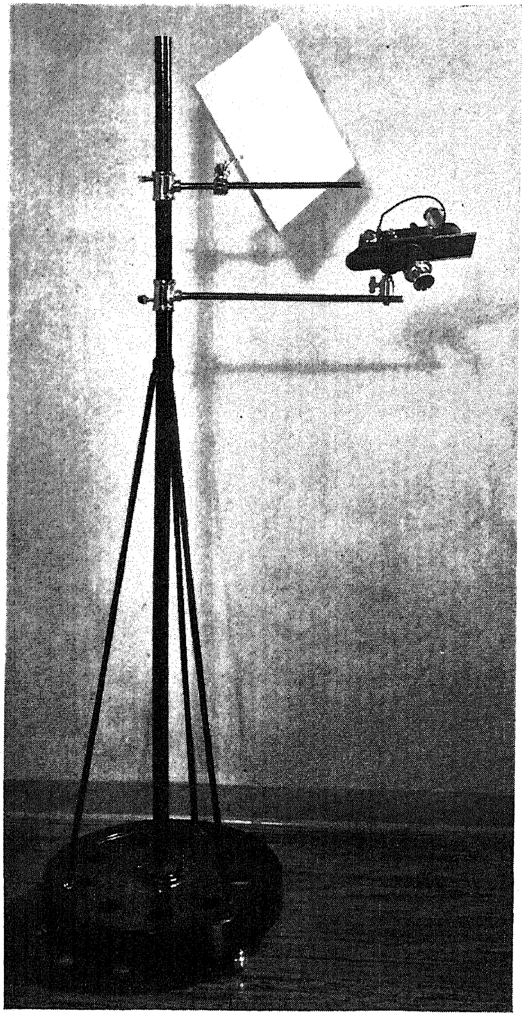


Fig. 245 Home-made Portable Camera Stand supporting Leica camera with Sliding Focusing Attachment and Reflector. The outfit is readily available for use at the dental chair. Both Camera and Reflector are easily adjustable, providing exceptional flexibility and rigidity.

cookie sheet. One side of it is kept with a high polish for strong reflections while the other is dulled slightly by a very fine sand paper or by sand blasting.

The camera is attached to the horizontal arm by a Leica Ball Jointed Tripod head. I have found nothing that will take the place of this device in holding the camera solidly in all positions. Figure 245 shows the construction of the entire support. It can be made very simply and inexpensively.

The Fuldy copying attachment is described on page 189. It is the ideal piece of apparatus for accurate viewing and focusing in close work. The proposed image is seen very clearly on the ground glass back. However, for the most careful focusing, I strongly urge the addition of the 5x magnifier and viewer.

For close-up work at least one and preferably two extension tubes are needed. A serviceable arrangement is to have the 12mm and the 22mm tubes.

Needless to say, the Weston Leicameter is indispensable. To attempt to photograph numerous objects under varying light conditions is too hazardous without some means of measuring the light value scientifically.

The Photoflood lamp should be mounted in some handy holder and reflector. If possible it should be set up close by, to be swung into position on a moment's notice. At least one spare bulb should be in reserve at all times. One ingenious way of saving the Photoflood, which burns only two hours, is to wire it through a Leitz Illumination Control which has seven degrees of measured light intensity (see page 159). Thus the light can be reduced to mild brightness for focusing and brought to the desired degree of intensity for the actual exposure.

Finally, with a yardstick, pencil, and the record pad described in the third section of this chapter the equipment is ready for use.

A picture of the apparatus set in position is shown in figure 244. When not in use the outfit is pushed back to the wall and the lamp swung to the side of the unit. Notice particularly how the camera support with its camera and reflecting board, and the lamp, are all adjusted in working position with no interference to the operator. For work in the laboratory or elsewhere in the room the camera support can easily be rolled into any position desired.

Making the Photographs

To illustrate the diversity of uses of photography in dentistry we start first with a series of pictures at the chair, then a series taken in the laboratory, in research, and in the preparation of papers or clinics. Many of the ideas presented in this chapter apply equally well to medicine and surgery and to the photography of all small objects.

The largest object photographed at the chair is the patient's face, both front view and profile. This provides a general record, particularly where any change is to be made in the front of the mouth. The main uses are in the young and the old, the children needing orthodontia and the elderly patients requiring full dentures. Such a picture will give an accurate record of the conditions to be reproduced or eliminated and will serve as a means of comparing the finished results with the original. Moreover, I feel it to be a very wise procedure, in this age when so many faces are disfigured in automobile accidents, to take full face and profile photographs of all patients.

For these pictures the ideal distance of the camera from the subject is twenty-two inches.

In most offices the full face picture (fig. 246) can be taken without electric illumination, daylight being sufficient. Formerly, I used one Photoflood with a reflecting board but now seldom use either in the full face picture. In the profile, help the lighting with one Photoflood and use a black

cardboard to serve as a background (fig. 247). Whenever using the aluminum reflecting board, adjust first the Photoflood light and then the reflecting board. Place the latter in position to reflect the rays from the Photoflood so that this secondary illumination will brighten the surfaces not struck directly by the Photoflood. The technique of adjusting the board is exactly the same that a small boy uses in annoying the neighbors with a penny mirror on a sunny day.

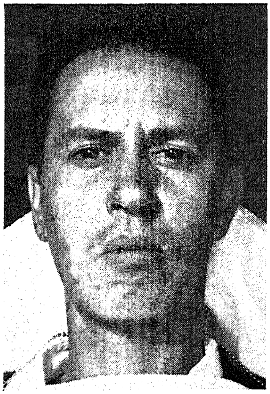


Fig. 246 (*left*) Full face view, made with Fuldy C. A. at 22", one second at f:18

Fig. 247 Profile, same case, data as above

The Fuldy copying attachment is indispensable for work in dentistry and close-up photography. In using the Fuldy copying attachment at a distance beyond 37½ inches, difficulty will be encountered from interference of the collapsible lens mount. This can be overcome as follows: With the focus lever set at infinity, work the lens into precise focus by sliding it in and out. Then swing the focus lever down to the opposite limit, 3.5 for instance. Next slide the camera across, swing the lever back to infinity, and all will be in proper focus and adjustment.

The next closest picture is that of the anterior teeth (figs. 248-251). For this put on the 12mm extension tube and bring the camera up to approximately nine and a half inches. The distance from the subject always means the distance measured from the subject to the back of the camera or the film, and not to the lens. In this and closer work on patients the Photoflood should be used. Figure 248 shows a picture in stronger lights and shadows, while figure 249 smoother lighting and less contrast.

A handy retracting device is shown in figures 249, 250 and 251. It is first formed as desired in wax and then converted into vulcanite. The method of use for the molar region is shown in figure 251.

Finally where a single tooth, or a group of two or three is desired, use the 12 mm and the 22 mm together, obtaining a 34 mm extension tube. Place the camera approximately eight and one-half inches from the subject. Study pages 198-199 on the decrease in light value with the use of extension tubes and plan your timing accordingly.

Focusing for Close-Up Objects

Figure 252 is an example of close-up photography. Notice not only the form and detail of the tooth as reproduced here, but also the bit of gauze pressed against the right central incisor. Here is an example of how a great deal of time and tension can be saved in the careful focusing for close-up work. First cut a small square of gauze

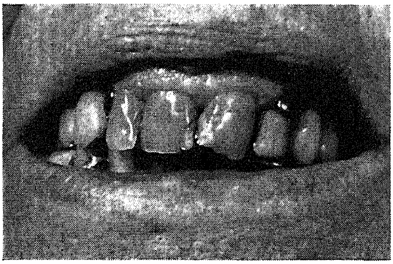


Fig. 248 22mm Tube at 9½″, one second at f:12.5

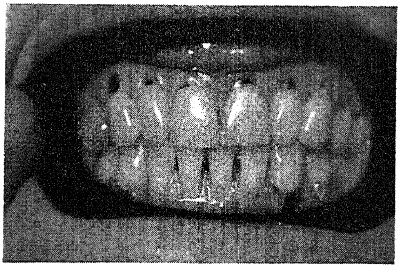


Fig. 249 22mm Tube at 9″, one second at f:18

from a dental napkin or other loose fabric material. Next select that position of the field most desired to be in accurate focus. If the field is flat it will be simpler. If it has considerable depth, as in figure 266 and you have computed what can be gotten into focus, locate a spot

Fig. 250 22mm Tube at 9½″, half second at f:6.3 (*overexposed*)

Fig. 251 12mm Tube at 12″, one second at f:18

which will be two-fifths of the way from the front limit toward the back limit. Place the square of gauze on the selected spot, wherever it may be, and focus on the gauze instead of any other object in the field. You will then be focusing on a hair-line instead of a flat surface.

The preceding pictures have shown how the field can be progressively diminished and the size of the teeth relatively increased. Study the usual attachments, distances and lighting for each type of

picture, and with but little practice you will soon develop a standard routine for each.

Transillumination of Teeth

Figures 253 and 254 show the effect of transillumination of an anterior tooth. Here we are confronted with the double problem of two lighting systems in use simultaneously. This should not be attempted until you have established a standard system of lighting for your own office which will give you results such as in figures 249 and 252. When that has been worked out to your satisfaction

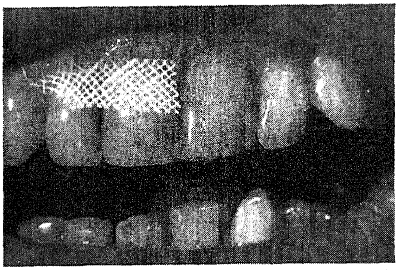


Fig. 252 12 and 22mm Tubes at 8¼″, one second at f:18

you are ready to run a series to determine the correct strength for the trans-illuminating light. First, reduce the main or standard lighting approximately 30 per cent below normal. I use the Ritter transilluminating lamp of the antrum type, as pictured in figure 268. Adjust it so that it has mild brightness and place it as shown, behind the

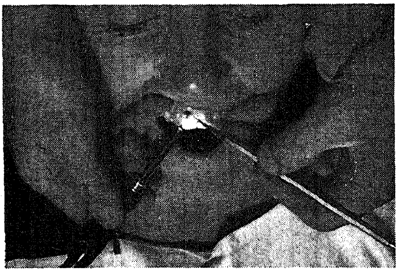


Fig. 253 12mm Tube at 17″, half second at f:18

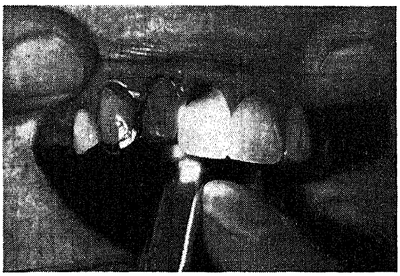


Fig. 254 22mm Tube at 9½″, one second at f:18

tooth. Record all factors, and particularly the number shown on the Ritter rheostat. Then photograph. Next increase the light of the Ritter lamp by one point and take the next picture. Keep increasing the voltage one point at a time for approximately five pictures, being certain to keep accurate records. From the finished results you can select the one which is to serve as your standard for future pictures.

The next two pictures, figures 255 and 256 are also examples of double lighting, although in these cases the transilluminating light is not shining through the teeth to be operated but onto them, a distant view and a close-up. Here again the same routine must be worked out as in the preceding paragraph, a series run to determine the correct balance of lights.

The main thing to bear in mind here is that it must be the Ritter light and not the standard light that has the correct brilliance. In other words, the transilluminating light must be such that it will neither over-expose nor under-expose the negative, while the standard lighting must definitely under-expose. And let me save time and money for you by again repeating that effects like these can be obtained only by running a series of exposures and keeping records.

Fig. 255 12mm Tube at 17″, 1/20 second at f:5.6

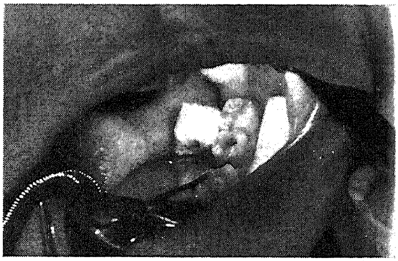


Fig. 256 22mm Tube at 10½″, half second at f:18

The extent to which the depth of focus can be increased by stopping down to a small aperture is shown in figures 253 and 255. The former was taken with the diaphragm closed to f:18, while the latter was opened to f:5.6. Notice particularly the clearness of the fingers. It is because of the increase of precise focusing on unimportant details that I prefer to close the aperture as much as possible. Having selected 18 as my standard aperture for most work, I can focus through the Fuldy attachment with the diaphragm wide open at 3.5, then swing the lever to the opposite extreme, or 18, entirely by the sense of touch. Eliminating the necessity of getting around and viewing the diaphragm reading in close quarters is a great convenience, and obtaining greater depth of focus is an advantage not to be overlooked.

Photographing Reflected Images

Another variation from the usual photograph is the one taken in the mirror. Figures 257 and 258 are two examples. The first is a picture of the entire vault of the mouth, with an inflamed mucosa irritated by a full vulcanite denture. The second shows a tooth following the treatment of pyorrhea by the surgical method. There are two precautions for this type of picture. First, the lighting must be studied very carefully to make sure that the area reflected in the mirror is as well illuminated as the surrounding non-reflected areas. It is the latter rather than the former that will determine the light value reading, so be careful. Second, the focusing must be done on

the reflected image. It must not be done on the non-reflected front surface of the object, nor on the glass of the mirror, but on the image shown in the mirror. With careful holding of the mirror this can be done as accurately as in the usual pictures.

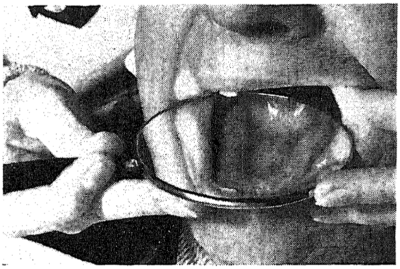


Fig. 257 12mm Tube at 10″, half second at f:18

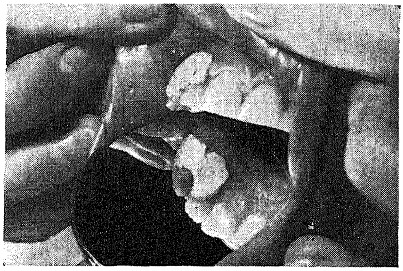


Fig. 258 22mm Tube at 9½″, one second at f:18

There is nothing that will take the place of the photograph in explaining the technique of many operations. Where subject matter is being prepared for lecture or publication, visual education should be the first considered. An example of this is shown in the two pictures, figures 259 and 260, where a fixed bridge is being seated with a rubber dam in position, showing the case before and after the operation.

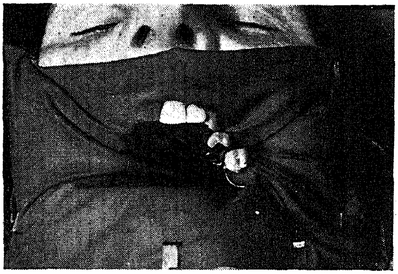


Fig. 259 12mm Tube at 13″, one second at f:18

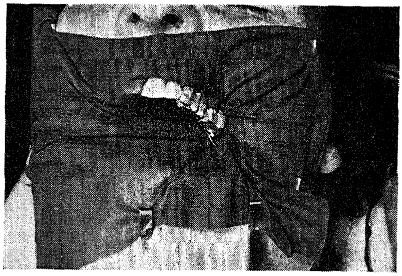


Fig. 260 12mm Tube at 13″, one second at f:18

In figure 261 an interesting method of eliminating background shadows is shown. Apparently the vulcanite bridge, a Dunn Temporary Bridge, is suspended in mid-air. The effect is obtained by supporting the object on plate glass and placing the cardboard background six inches or more below the glass.

At this point it might be well to refer to backgrounds. Strong cardboards should be on hand for use at all times, including black, dark gray, light gray, and white surfaces. Often the background

proves to be the salvation of the picture, especially with the smaller objects.

Other types of cases are illustrated in succeeding pictures. An unusual emergency denture repair is pictured in figure 262. Here the points of significance from a photographic standpoint are the reproduction of the roundness of the porcelain teeth, obtained by a proper lighting, and the great depth of field, obtained by stopping down to a small diaphragm and timing accordingly.

Figure 263 illustrates how photography is an aid in the instruction of cavity preparation. Figure 264 shows plaster models of a case before and after orthodontic treatment.

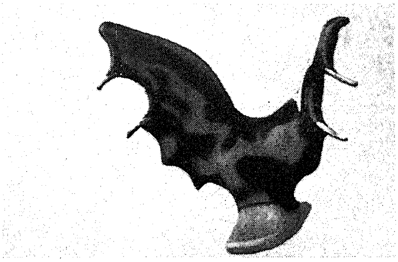


Fig. 261 12mm Tube at 9″, four seconds at f:18

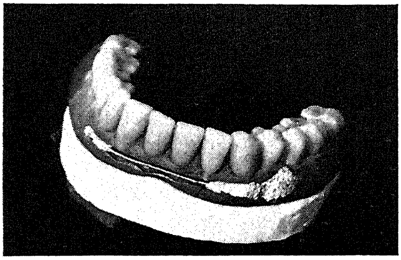


Fig. 262 22mm Tube at 10″, four seconds at f:18

Determining Exposures

Figure 250 shows the result of a mistake that is apt to be made very commonly in this type of work, that of over-exposure. Recognize in measuring the light value in these cases that the teeth form a very small part of the face and are much lighter than the rest of the face. For it is not the teeth so much as the skin that determines the Leicameter reading. If a photograph is made, based on the Leicameter

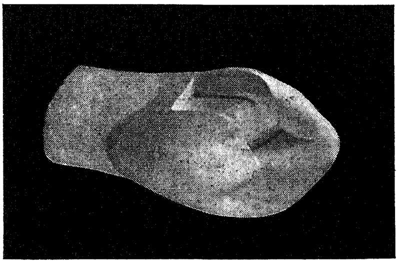


Fig. 263 12mm Tube at 12″, two seconds at f:18

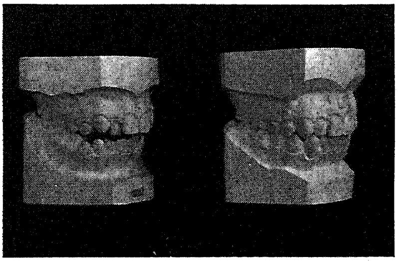


Fig. 264 12mm Tube at 17″, two seconds at f:18

reading obtained directly, it will be flat and burned up, as shown in figure 250. If the time is cut considerably the result will be as in

figures 248 and 249. Another suggestion regarding this is told in connection with figure 264.

One is likely to be deceived as to the true light value of small objects, particularly where they are very light in color. This is well demonstrated in the case of these three plaster models. Placed on a black background, the greatest light value they would record was slightly toward 0 from 1. With the Leicameter set for a film with a speed of 23, the correct camera adjustments were shown to be 13 seconds at aperture 18. However, this was felt to be far beyond the correct timing.

To determine the correct exposure a large white card of approximately the same degree of brilliance as the plaster was held in place just in front of the models and a reading taken of the card. Instead of slightly less than one, the light value now proved to be 1/6 and the adjustments this time were changed from 13 seconds at 18, to 1½ seconds at 18. The picture as shown was made with the latter adjustments.

In your initial work on each new type of case, you will save time by running a series of pictures, all of the same subject. For instance, figure 263 was obtained first by finding that the light value was probably 1/6. Then a small diaphragm, f:18, was chosen in order to have maximum depth of focus. Finally a series was run starting at 1 second, then 2, 3, 4, 5, and ending with 6 seconds, but without the series of pictures I could not have been certain. As originally computed with the aid of the Leicameter reading of the white card, the 2 second exposure proved to be ideal. Again let me urge you always to run a series of exposures in undertaking a new type of work, then select the best and use that as standard from then on.

Occasionally there will be a case where the arranging of objects and studying their most desirable positions is difficult. All of the plaster models were such examples. The slight turning of one would throw certain lines in and others out, and the reduced image as viewed on the ground glass of the Fuldy attachment made adjustment difficult. In such a case place the object in general focus and approximate arrangement, then slip the camera off of the copy attachment, quickly unscrew the lens and you have an open hole through which to view. Using it as a frame for your picture, do the final arranging of the object, then replace the lens and camera and complete the photography. This aid is seldom needed but can be of great help in studying arrangement in difficult cases.

Research work can be recorded as shown in figure 265, representing a steel die and brass tube testing the precision of a gold casting, and again

in figure 266, a human jaw showing a deep pyorrhea pocket (indicated by the arrow), and the effect of occlusal attrition.

Other objects which can be photographed are such things as radiographs (fig. 267), collections of interesting dental appliances, the operator's hand demonstrating a certain technique (fig. 268), and so forth.

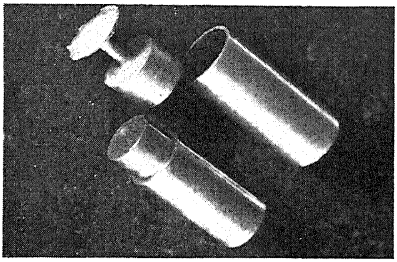


Fig. 265 Hollenbeck Tube Dies. 22mm Tube at 9″, four seconds at f:18

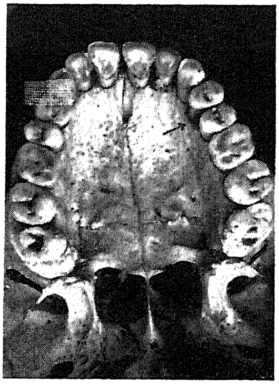


Fig. 266 (*right*) 22mm Tube at 11″, four seconds at f:18

The high magnification that can be obtained by the use of extension tubes is shown in the typodont of gold foil work (figs. 269-271, typodont by Dr. E. D. Shooshan, Pasadena, Calif.). The picture of the gold foils in the upper right first molar, the single tooth and the typodont, are all enlarged to the same degree from their original pictures. The relative enlarging was done in the photography by means of the tubes, and not in the printing.

The color record of the light pink of condensite material is shown in this typodont. The color record which vulcanite will give is shown in figure 262. The anterior portion was gum pink and the posterior portion maroon. Figure 261 also shows maroon vulcanite. No color filters were used.

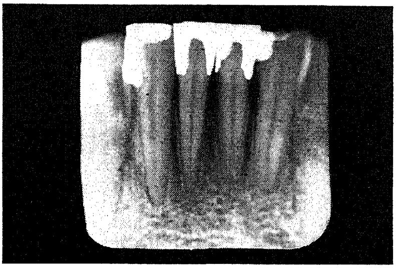


Fig. 267 22mm Tube at 10″, four seconds at f:18

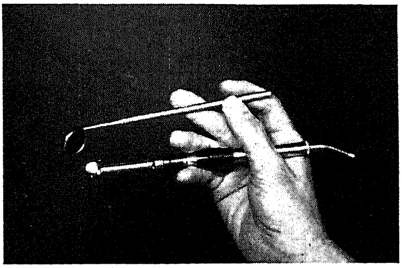


Fig. 268 22mm Tube at 12″, one second at f:18

In the photographing of small inanimate objects I prefer the soft light of daylight rather than the artificial illumination of electricity. Figures 261, 263, 264, 266, 271, 269 and 270 were all made without artificial illumination. The objects were placed on a small stand close to one window. There was one other window in the room which was used to help modify the shadows.

Some objects, however, require stronger highlights and shadows. These can be illuminated best with a Photoflood serving as the spotlight, and daylight providing the floodlight. Figures 262, 265 and 268 are examples of this type. The lighting of figure 267 was obtained by placing the radiographic film on a radiographic viewing box.

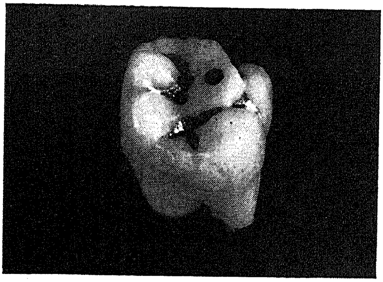


Fig. 269 12 and 22mm Tubes at 8¼″, six seconds at f:18

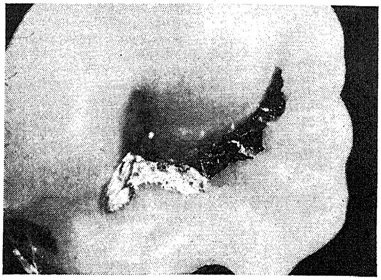


Fig. 270 90, 60, 22 and 12mm Tubes at 12½″, twelve seconds at f:22

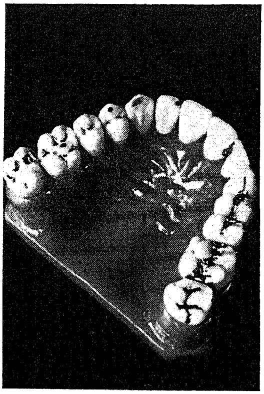


Fig. 271 12mm Tube at 9″, four seconds at f:18

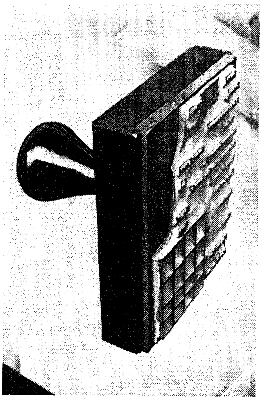


Fig. 272 Record stamp

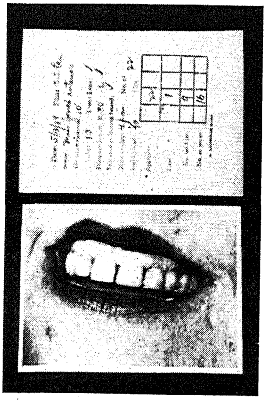


Fig. 273 Print with record on back

Importance of Keeping Accurate Records

The photographer who is interested in reproducing rapidly any type of scene must work out a systematic routine based on accurate records. This is particularly true of photography in any phase of science, where close-up apparatus is used and slight variations are of great importance. Here the subject is frequently a patient and time must be conserved for all involved.

Following is a routine which will permit check-up and reference:

1. Prepare a pad of paper. With a record stamp (fig. 272), stamp all sheets on the pad.
2. Place subjects as desired, adjust camera and lighting.
3. Use Leicameter. Determine light value and select correct aperture and time.

4. Now — — — — — — — — — **STOP** — — — — — — — — — and

RECORD EVERYTHING

5. If planning to take more than one shot of this subject (possibly experimenting with varying apertures and timing) record (on chart fig. 273) EVERY shot in that series, BEFORE TAKING A SINGLE PICTURE.
6. Then photograph AS PLANNED.

Following the development of the film, study it through the Leica film viewer and marker. By means of this device clip a notch on the border of the film to designate each picture to be enlarged.

Another method of choosing the pictures to be enlarged is to make strip prints from the entire film and then make your selection. If you use this routine be sure to mark the small prints in some suitable manner and in addition return to the film and clip the notches. This is particularly important where you have taken a number of test exposures of the same subject.

Numbers are to be found marking each picture on some brands of film, while others are blank. Those that are blank should now be numbered on the film in ink to correspond with the numbers on the last line of the record chart. Those films which have numbers on the border, will seldom be found labeled 1-36, but are more apt to be numbered 22-36, 1-21, or 14-36, 1-13, etc. Therefore, these numbers which appear on the film must be recorded on the next to bottom line on chart.

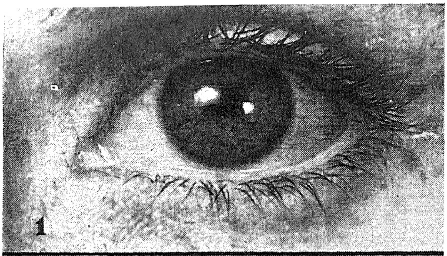
When an enlargement (fig. 273) has been printed, turn it over and stamp the record chart on its back. Then fill in all data found on the original chart for that print. Now devise some filing system. For mine I have chosen to paste the pictures on 9″ x 12″ sheets of heavy paper that come in an I-P class G T sectional post binder, top-locking #7717. I have strip prints made of the entire film and paste those for one film on one sheet of paper. For quick reference I now write the numbers on the strip prints, and it is at this point that I mark each print to be enlarged. The papers carrying the enlargements have the record chart stamped on them and filled in beneath each enlargement. Any enlargements which are not mounted are stamped as shown above in figure 273.

It seems a bit safer not to cut the negatives but to store them in the metal film box. Here they are ready for instant use by referring to the strip prints.

The result of the above will be a systematic record of all factors involved in obtaining every photograph. When you have a new photograph to take you can very readily pick out from your file the print most closely resembling it and proceed by duplicating the recorded factors.

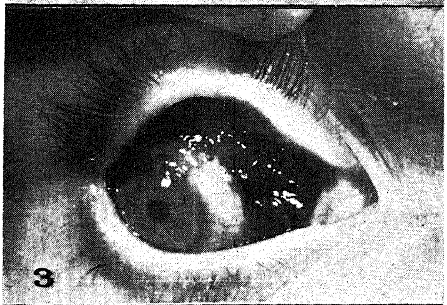
Above all, remember this. Any record routine that is developed along systematic lines will prove invaluable to anyone anxious for scientific results. It can be a routine very different from the above and still be a system. It is not important to copy this one, which I know works in a highly satisfactory manner and saves time and money. It is important, however, to develop some routine which is systematic, accurate and complete.

LEICA photos by
Dr. Ramon Castroviejo



Normal Eye.
50mm Summar, f:12.5, 1/20 sec.

Tumor of lower Eye-lid.
50mm Elmar, f:9, 1/8 sec., 3cm tube.



Pigmented Condition of the Eye.
50mm Elmar, f:9, 1/8 sec., 3cm tube.

Congenital Coloboma of the Iris.
50mm Elmar, f:9, 1/8 sec., 3cm tube.
Dupont Superior film.

Greater Enlargement of No. 4.

LEICA AS AN OPHTHALMIC CAMERA

HENRY M. LESTER **CHAPTER 21**

Photography of anterior segments of the human eye for scientific and medical purposes presents problems peculiarly its own. A photographic camera directed at an eye actually faces another camera, and a well designed one too, to say the least. Besides this our camera faces one of the most sensitive and delicate centers of the nerve sys tem, a very delicate and accurate optical organ and a convex mirror, photographically speaking: a wide-angle reflecting surface.

To produce photographs of an eye one needs a good camera with an optical system as flexible as possible. One needs good and suitable illumination capable of delivering the light required for short exposures without unnecessary strain to the eye. One needs fast films with broad latitude of emulsion and with a full color correction. And plenty of patience!

If it is difficult to make precision still photographs of the eye, it is harder yet to take motion pictures of it. This is particularly true in cases where the eyes to be photographed are diseased or abnormal, extremely sensitive to light, easily irritated by prolonged exposure to air. Such eyes are usually in motion, almost constantly. But even if it were possible to immobilize them for a moment the iris would never remain stationary: the movement of this remarkable living diaphragm cannot be controlled at will; the size of the aperture, the pupil, is constantly changed as the iris contracts or distends. Strong light, such as is required for short exposures is almost invariably unbearable to the eye, causing irritation accompanied by lacrimination, nervous movements of the eye-ball, eye-lids and the entire head.

During a recent production of a motion picture dealing with subnormal vision and describing various optical devices, spectacles and other aids designed to overcome this handicap, a number of "close-ups" of eyes (anterior segments) were required to show the specific condition of the case for which the particular type of spectacle was being designed. The motion picture was to amplify a lecture by showing and explaining visually to the profession the technique of examination of eyes having sub-normal visual acuity, the

optical principles underlying the construction of the different types of telescopic spectacles, pin-hole spectacles, compound magnifiers, contact lenses, etc. The various deformities and anomalies encountered in cases of sub-normal vision had to be shown to demonstrate available methods of optical treatments of the different types of defective vision.

It was felt that it would be useless to expose patients to the strain, discomfort and hardships of motion picture photography for close-ups of anterior sections. It was found that "stills" of these anterior segments, showing the affected eyes in great detail, when rephotographed on motion picture film yielded all that was desired and even more, having several advantages. Besides, these "stills" were usable for making of lantern slides and also for case history records.

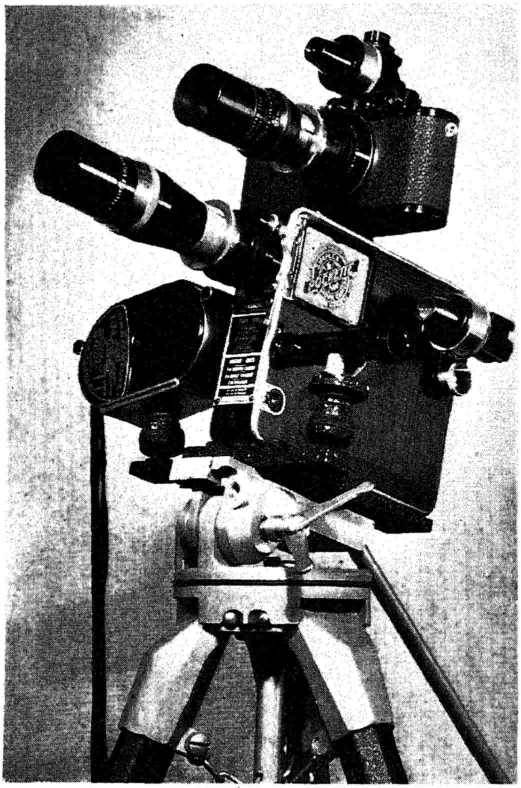


Fig. 275 Leica mounted on a Simplex-Pockette 16mm motion picture camera outfit for making still and motion pictures at the same time. The author assembled this outfit for his medical and scientific work

The entire picture (some 1600 feet of 16mm film) was produced within eight weeks. Two Simplex-Pockette cameras were used in the production. Figure 275 shows one of these outfits specially adapted for this work. The Leica camera was mounted atop the motion picture camera, where it performed double duty: it was used to check exposures and general lighting arrangement of each set-up, and to produce "stills" of every scene quickly, stills that were easily available, easily reproduced and enlarged to any size desired. This outfit was used for the general work: long and medium shots. For close-ups of anterior segments, requiring utmost precision, another outfit was designed and assembled.

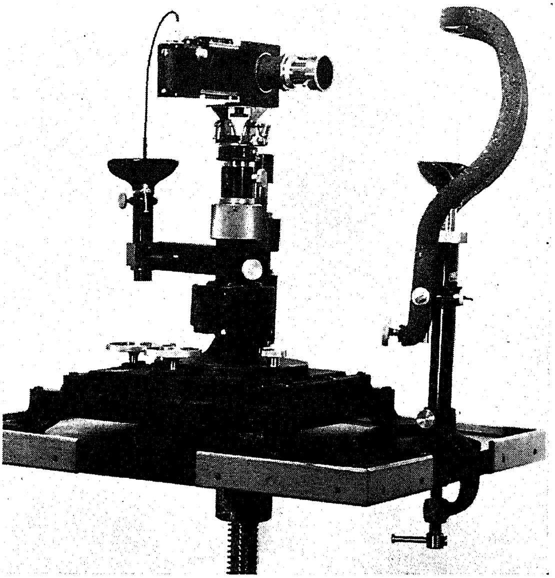


Fig. 276 The Leica as an Ophthalmic camera

The Leica Equipment

A Leica was mounted upon a heavy compound base of a binocular ophthalmic microscope. The base, equipped with cross-slide adjustable movement was particularly well adapted as a support for the camera; while extremely rigid it permitted free and fully controlled movement of the camera in every desired direction for adjustment and focusing. Thus mounted upon the base the camera was placed on a heavy adjustable instrument table equipped with an elevating gear and an adjustable head-and-chin rest. The entire outfit was very heavy and rigid, permitting accurate and dependable control of the equipment at all times without being subject to vibrations. The illustrations show the arrangement as used in detail.

The outfit was assembled from the following units and parts:

1. Leica Camera Model F.
2. Lens Shade.
3. Spirit Level.
4. Cable Release.
5. Compound Binocular Microscope Base.
6. Instrument Table with Head and Chin Rest.
7. Sliding Focusing Attachment Model No. 1.
8. Magnifier with adjustable collar for above.
9. Special Attachment Ring (ordinarily used on the lens when used in the Valoy enlarger).

Two diagonal hair-lines were etched into the surface of the ground glass of the Focusing Attachment for better centering of the image. Greater brilliance of the image upon the ground glass was obtained by rubbing in a drop of oil into the ground side of the glass.

The magnifier not only aided materially in critical focusing, but also acted in lieu of a focusing cloth, keeping out extraneous light during focusing on the ground glass. The spirit level was used to obtain better alignment of the camera with the optical axis of the eye to avoid distortion. The special attachment ring was used over the lens to facilitate the operation of the lens diaphragm. It also served admirably as a lens shade. In addition to the above the following color filters in mounts were used: Panchromatic X1 and X2, Yellow No. 1 and No. 2 and Red (A).

The optical equipment consisted of the standard Elmar 50mm f:3.5 lens and the 30mm extension tube. It was found that this lens has excellent sharpness, correction, definition and resolving power. This lens, when used in connection with the 30mm extension tube mounted upon the Sliding Focusing Attachment produced images of the eye upon the film almost normal size. When set for infinity with the working distance from the eye being 108 mm the exact ratio of the size of the object to the size of the image of film is 1:0.82.

The Focusing Attachment with the camera connected to it was mounted upon the compound base by means of a brass key which fitted into a groove in the head of the base. A set screw tightened the connection rigidly. This arrangement rendered the camera outfit easily interchangeable with the microscope, thus permitting the use of either at will. It also assured utmost rigidity and freedom from play and vibration, the importance of which cannot be overemphasized.

The outfit having been assembled, considerable experimental work preceded the actual taking of pictures of cases. The entire procedure of photographing anterior segments had to be standardized and

simplified before patients were requested to sit before the camera. Correct exposures, arrangement of lights, type of film, filters and many other details had to be worked out and definitely established.

Correct exposures were determined with the Weston Photo-electric Leicameter. Factors of film, filters, and extension tubes being known, it was a simple matter to arrive at the correct timing of the shutter. The factor of the 30 mm tube with the lens set at infinity is 2.2 x. The lens was usually stopped down to f:9 or f:12.5. Such small apertures were required to obtain greater depth of focus. Good definition was obtainable at these apertures of all parts of the eye, including edges of eye-lids, corners of eye. The maze of capillary blood vessels of the selera (white, opaque portion of the eye-ball) was also always in sharp focus. This depth of focus, though not essential to the picture, imparted usually a feeling of roundness and depth, with resulting life-like appearance of the eye.

The success of the work depended not only upon a standardized procedure of the technique of photography, but also on uniformity of materials, processing and laboratory work. For film the Du Pont Superior Panchromatic was selected because of its latitude of emulsion, speed under artificial light, its color correction, response to filters and its grain structure. All film was developed, hardened, fixed and washed in Correx tanks. For developer the well-known Du Pont fine-grain formula was selected: it yielded fine grain with minimum loss of speed and definition; this formula is known as Dr. Sease No. 3. (See chapter on Film-Development.)

The use of color filters was avoided as much as possible. Only where it was absolutely necessary were they put into service. Particularly, where special colors required it for the purpose of correct monochromatic rendering the color filters were resorted to. An example of this is offered in figure 277.

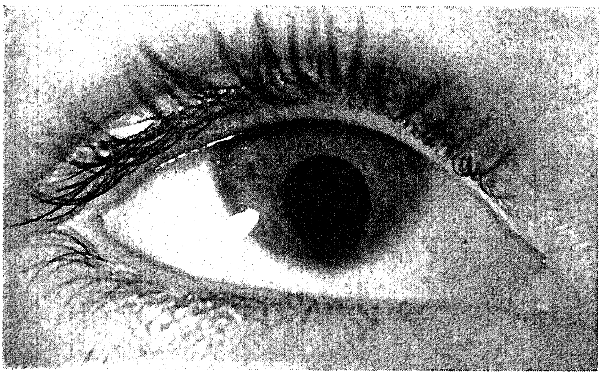


Fig. 277 Congenital Coloboma

Elmar 50mm lens, 30mm Tube. Photoflash exposure at f:12.5. DuPont Superior film. Red (A) filter

This photograph showing a case of a congenital coloboma of an eye was made with the Wratten (A) Red filter to separate the dark brown iris from the black pupil. The same photograph made without this filter showed no appreciable difference between these two colors.

Importance of Focusing

Focusing of the image on ground glass was usually done with the lens wide open. Subsequently it was stopped down to the desired aperture. For this work the special Attachment Ring placed on the front of the lens was almost invaluable. With the eye only 4-5 inches away from the lens, it would have been difficult to reset the lens diaphragm to the desired stop without disturbing the patient. This ring has outside calibrations, which though not in "f" values are easily memorized as to their equivalents. The patient was placed

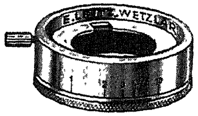


Fig. 278 Attachment Ring, which is extremely useful for adjustment of lens diaphragm (Elmar or Hektor 50mm) in close-up work. It acts also as a lens shade

comfortably in the chair, the table raised to a level where the lens of the camera was opposite the eyes, and then the vertical and horizontal fine adjustments were made by means of the rack-and-pinion of the cross-slide movement of the base. The head of the patient was made to rest upon the chin rest, after which the focusing was made, the lights turned on and the exposure quickly made.

Illuminating the Eye

Which brings us to the most trying and difficult problem of photographing the eye: the illumination. The eye acts as a wide-angle mirror-like reflecting surface (convex). Not only will it reflect the light source, but, under certain conditions, the camera and its operator as well. Photographs of the eye, therefore, should be made in a room free from illuminated objects or light sources other than those used for the direct illumination of the eye. There should be no light entering through the windows, no skylights, nor ceiling lights. Lights used for illumination should be placed as far as possible from the eye to render their reflections small and inconspicuous. Total lack of reflection in the eye is not desirable, because these reflections lend the picture of the eye that spark of life, that roundness and fulness which distinguishes it from a dead eye.

It is difficult to illuminate a normal eye sufficiently for an instantaneous exposure of a small lens aperture. Prolonged exposures

are undesirable because of the ever-present possibility of movement of the eye. But there are abnormal, diseased eyes, with all kinds of lenticular, retinal, corneal involvements, which actually abhor light. There are cases of Photophobia (which does not mean that they abhor photographers, although they actually do!); light, even daylight, hurts them. Their eyes must be shielded, protected from light, and not exposed to it.

Thus, although the entire process of photographing anterior segments was standardized sufficiently to form a kind of routine, the matter of handling, selecting and arranging lights had to be treated differently in each and every individual case. It had to be made to suit not only every patient, but the condition of each eye as well; for there were cases where one eye was entirely different from the other. Before the patient was placed before the camera, the reaction of his eyes to light had to be definitely and carefully determined by the doctor.

Flashlight Eye Exposures

In the case of eyes particularly sensitive to light, the most satisfactory method of illumination was found in the Photoflash bulb. The bulb was usually placed in the reflector of a goose-neck type floor lamp. A diffusion screen was placed before the photoflash bulb; not so much because of the intensity of the light, but because these bulbs occasionally crack or break when flashed. The tiny, thin fragments of glass would be dangerous to the eye of the patient, and one cannot be too careful in protecting it. The reflector was usually placed some five to six feet away from the eye, slightly above its level and to one side of it. On the other side of the eye a white reflecting surface was placed to provide even illumination, thus imparting roundness to the picture. Actual focusing was done with the light of a 15-watt bulb, placed conveniently near the camera. The shutter of the camera was synchronized with the switch of the bulb; and at the moment sharp focus was obtained, the exposure was made.

In most instances the patient was barely aware of an intense light sensation in connection with the flash, which lasts only about 1/50th to 1/75th of a second—too short to register any intensity upon the retina of the eye. To be sure of critical focus, it was at times necessary to use a special head-and-chin rest for the patient. The rest was provided with a small piece of flat wood, attached crosswise. The patient was asked to hold the wood firmly between his teeth during focusing, retaining the assumed position for the exposure.

Eyes with normal reaction to light were photographed with the aid of two 500-watt bulbs, or two Photoflood bulbs, in suitable reflectors with tracing cloth diffusers. The reflectors should not be of the polished type, but of the oxidized, dull, aluminum finish, to avoid reflections of filaments upon the subject. One light was placed on each side of the eye; one closer to it (four to five feet), the other farther away (six to eight feet). The farther the light source from the eye the smaller its reflection in the eye. Frequently a white reflecting surface placed on one side of the eye replaced the second light, but at some increase in exposure. Focusing was again done with the light of a low wattage bulb conveniently placed near the camera and near to the patient's eye.

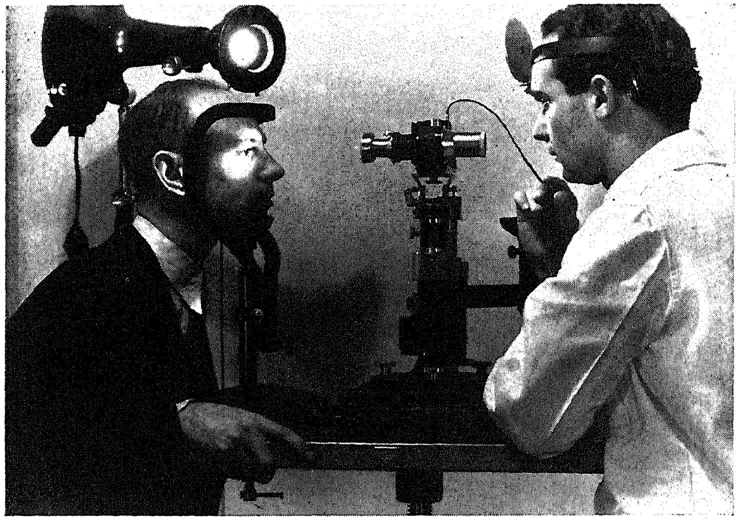


Fig. 280 Dr. R. Castroviejo using the Leica for photography of anterior segments of the eye. Adequate illumination is secured by means of head mirror reflecting powerful spotlight at time of exposure

Leica for Clinical Photography

I am indebted to Dr. Ramon Castroviejo of the Opthalmic Institute, Columbia-Presbyterian Medical Center, New York, for extremely valuable information and ingenious methods of illumination of anterior segments of the eye. Dr. Castroviejo assembled independently a Leica outfit for this work, quite similar to the one described here, with which he obtains some remarkable photographs of anterior segments. He was good enough to demonstrate some of his work and to permit me to use some of his Leica pictures,

which are shown here. Dr. Castroviejo's work is remarkably well illustrated with Leica photographs, only some of which can be shown here.

Dr. Castroviejo uses his Leica outfit as an Opthalmic camera extensively in his clinical work The results of his surgical and therapeutic treatments of eyes are constantly and periodically recorded photographically, furnishing a most detailed visual record for his case histories. Many photographs thus obtained are subsequently made into lantern slides, and used in lectures.

Illustrations which follow show the ingenious illumination methods used by Dr. Castroviejo.

In setting up and operating the Leica Opthalmic equipment Dr. Castroviejo proceeds as follows:

1. A standard surgical spot-light equipped with a 500-Watt bulb and a water filter as well as a system of condensing lenses for focusing and narrowing the beam of light is placed alongside the patient.

2. The beam of light is directed at the head of the person operating the camera.

3. The operator wears a head-mirror of the kind used by nose and throat specialists during examination of interior organs. The beam of light from the spot-light strikes the mirror and is reflected by it in any direction desired.

4. By means of slight movements of the head the operator is in a position to direct the beam of light upon the eye to be photographed for as short or as long a time as indicated.

5. The camera is focused as usual, the operator standing behind it opens the camera shutter and at the same time by a mere nod of his head makes the beam of light pass quickly across the eye.

6. Directly afterwards the shutter is closed.

7. With a little practice remarkable ease is acquired producing excellent results with minimum discomfort to the patient. The beam of light need remain upon the eye a mere fraction of a second.

Another method used by Dr. Castroviejo consists of placing the same spot-light opposite the patient's eye, alongside the camera, with the beam directed at the eye. In this case use is made of the compur shutter with which the spot-light is equipped, controlled by a cable release. The shutter has speeds of 1/25 to 1/50 of a second. After

focusing the camera with the aid of a low-wattage bulb, the spot-light is turned on with the compur shutter remaining closed, but set for the desired speed. Opening the shutter of the camera, releasing the shutter of the spot-light, and closing the shutter of the camera, takes less time than to say it! The illustrations show details of these various set-ups.

Use of the Placido Disc

Several photographs were required of eyes with deformities of the cornea. The cornea (the outer transparent part of the eye-ball) of a normal eye is spherical, forming a segment of a sphere slightly smaller in diameter than that of the eye-ball itself. It is smooth and glossy. Its roundness and smoothness enable it to act as a convex reflecting surface. In some cases the cornea assumes shapes different from normal, sometimes resembling a cone, in other cases it develops deformities of the outer surface, irregularities of the curvature, wrinkles, etc. All of these deformities result in distorted and defective vision. Some of them are very slight, however, barely visible to the eye. The fact that a normal cornea acts as a convex mirror had been utilized in the detection of these irregularities and in their accurate measurement. A white disc (known as the Placido Disc), some 12 to 18 inches in diameter, upon which had been drawn concentric black circles about 1 inch wide and about 1 inch apart, is placed in front of the eye. Through an aperture in the center of the disc one can observe the reflection of this disc in the eye. A normal cornea will reflect a true reduced image of these concentric black and white circles, fully retaining their roundness, spacing and concentricity. A malformed cornea will reflect a distorted image, from the nature, shape and direction of which the character of the malformation can be diagnosed and measured.

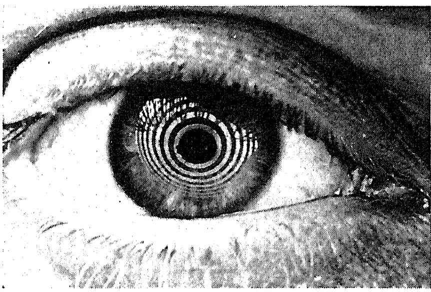


Fig. 281 Placido Disk Reflection in Cornea of Normal Eye

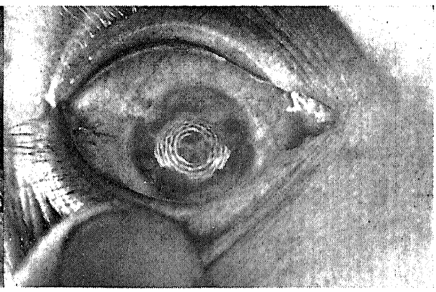


Fig. 282 Placido Disk Reflection in Cornea of Diseased Eye

To obtain photographs of reflections of Placido Discs in normal and in abnormal eyes the same Leica outfit was used, but the illumination was changed. A Placido Disc was placed over the lens, which was accomplished by inserting into its center aperture a black paper tube (about 2″ long), which in turn was slipped over the Leica lens. The black paper tube acted as an extended lens hood. The center of the Placido Disc was made to coincide approximately with the optical axis of the lens. Two 500-watt bulbs in reflectors were placed slightly behind the patient and the light was directed at the Placido Disc. The light reflected from the white portions of the disc served to illuminate the eye. In arranging the lights care was taken to prevent direct rays of light from striking the elements of the lens. The following illustrations show a photograph of a normal eye and that of an eye with a distorted, malformed cornea.

Portraits of Patients

The flexibility of this Leica outfit made it possible to use it for still another purpose. By simply removing the 30mm extension tube and mounting the 50mm lens directly upon the sliding focusing attachment one secured a portrait view camera with a ground glass upon which to compose the picture. Focusing in this case was accomplished by unlocking the lens barrel of the Elmar 50mm lens (turning it counter-clockwise) and moving it in and out. Portraits of patients were wanted for case histories and records to show the marked difference in facial expressions resulting from improved vision. The tired, haggard and tense expression typical of a patient during his early examinations was usually superseded by an expression of ease and contentment after the correct spectacles were fitted. For this purpose photographs of the head and a portion of the shoulders were wanted. For photographs of anterior segments the patient was asked to lean forward in his chair and to rest his head upon the chin rest. For portraits the same patient was asked to lean upon the back of the chair. The change in the focal length of the lens, produced by the removal of the extension tube, permitted making these two different pictures without moving the camera, nor for that matter disturbing the patient, who did not have to leave the chair.

Fig. 283 Record Photograph of Patient Wearing Pin-hole Spectacles

Subsequently a system of records of cases was developed consisting of mounting on the back of history cards pictures showing the patient at first examination, anterior segments of his eyes, and a photograph of the patient wearing spectacles designed for him. A photograph of such a portrait is shown here.

The usefulness of this Leica outfit did not stop after the completion of photographs of anterior segments and portraits of patients. Another phase of the motion picture work offered great difficulties,

and again the Leica was put to work and successfully used as a short-cut. In explaining the principles underlying the construction and design of various spectacles used as aids to eyes affected with sub-normal vision it was desired to *show* how a beam of light is refracted in passing through the medium of a lens, what happens to it when it enters the eye, and how the path of this beam of light can be controlled to produce an image upon the retina by making it pass through certain media before entering the eye.

Smoke Box Photography

A schematic model of the eye was built of glass. Also a special "smoke box", consisting of a wooden box, painted with dead black coating inside. One of the sides of the box was fitted with plate glass, which enabled observation from the outside. At one of the ends an opening was made through which a beam of light could be admitted. An optical bench was placed inside the box, and various lenses, slits, prisms, pin-holes and similar media were mounted upon it aligned along the same optical axis. A strong source of light was placed on the outside of the box with the beam light entering the box through the side opening. The bunch of rays entering the box was made as nearly parallel as possible. When the box was filled with smoke the path of rays became plainly visible in a darkened room. The rays were made to pass through lenses, prisms, slits, pin-holes, etc., and as a result were made to converge, diverge, change direction, intensity, etc. At the end of considerable experimentation to produce the desired results this turned out to be an interesting and quite a dramatic spectacle. But the motion picture camera was blind to it, despite fast lenses and fast films! Although a very strong source of light was

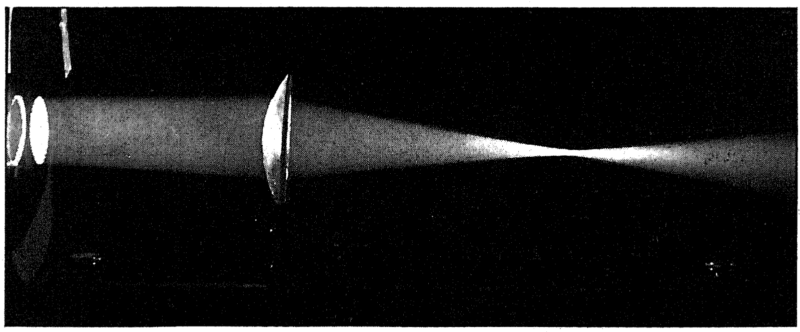


Fig. 284 Smoke Box photograph showing behavior of bundle of rays after passing through convex lens

Elmar 50mm lens. Three minutes at f:18. DuPont Superior film. Red (A) filter

used, its actinic value was slight. Because what we saw was, of course, not light itself, but merely the illuminated minute particles of smoke, which reflected less light the farther away they were from its source. To intensify these illuminated particles, a bit of powdered chalk was shaken into the smoke box just before the exposure was made.

The Leica was used to record these set-ups. When enlarged these photographs were rephotographed on motion picture film, producing results which were found to be excellent in every way. The camera mounted upon its rigid support described previously was as free from vibration as possible. This was important because very long exposures were required: with the lens stopped down to f:18 and with a red (A) filter used to retard the light and to bring out some detail in the shadows of the set-up and equipment inside the smoke-box—the exposures ranged from 2 to 5 minutes! The following illustrations show these actual photographs obtained in this manner and subsequently incorporated into the motion picture film.

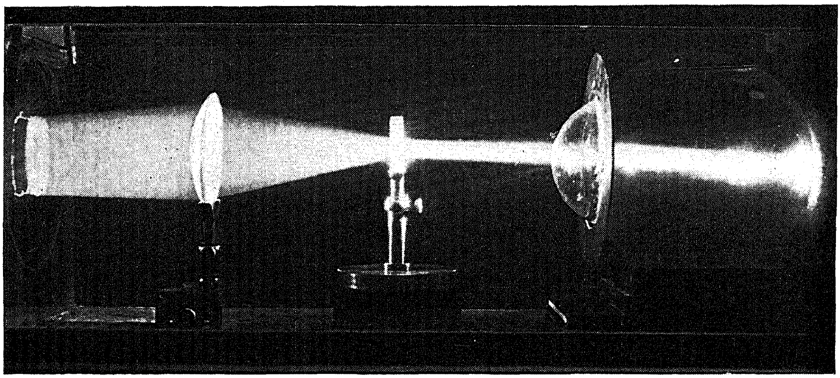


Fig. 285 Smoke Box photograph
showing behavior of bundle of rays after passing through simple "telescope", entering model of eye and forming image upon retina. Exposure as in Fig. 284

These photographs had to be produced in a darkened room. All those present in the room had to remain motionless throughout the long exposures. To prevent vibration caused by street traffic and subways the actual exposures were made between 2 A. M. and 5 A. M.

When reproductions of these photographs were later flashed upon a screen as a part of the motion picture they appeared just as real as if they were produced directly upon the moving film, there being no action, but merely an even and steady flow of light. Thus these stills were just as effective, but much, much simpler to make than by means of a "stop-motion" mechanism on the motion picture camera. Cor-

rect exposures for these photographs were obtained by the tedious, but infallible method of trial-and-error. Exposures varied with every set-up because of various light intensities resulting from the use of various media through which the light was made to pass. The preparation of each set-up was so tedious that some three to six shots of each were made: just to play safe.

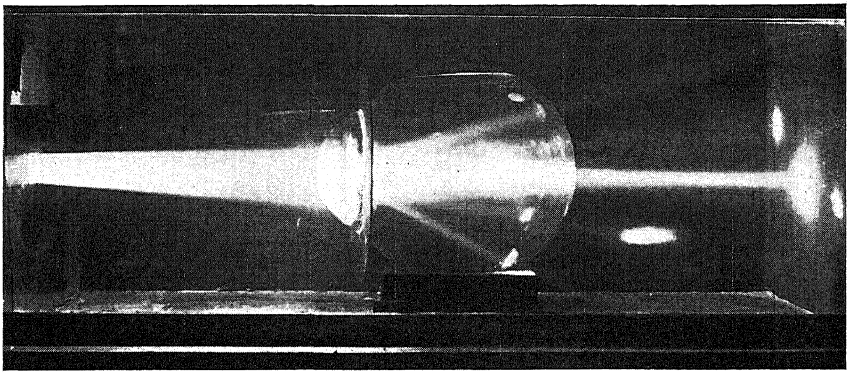
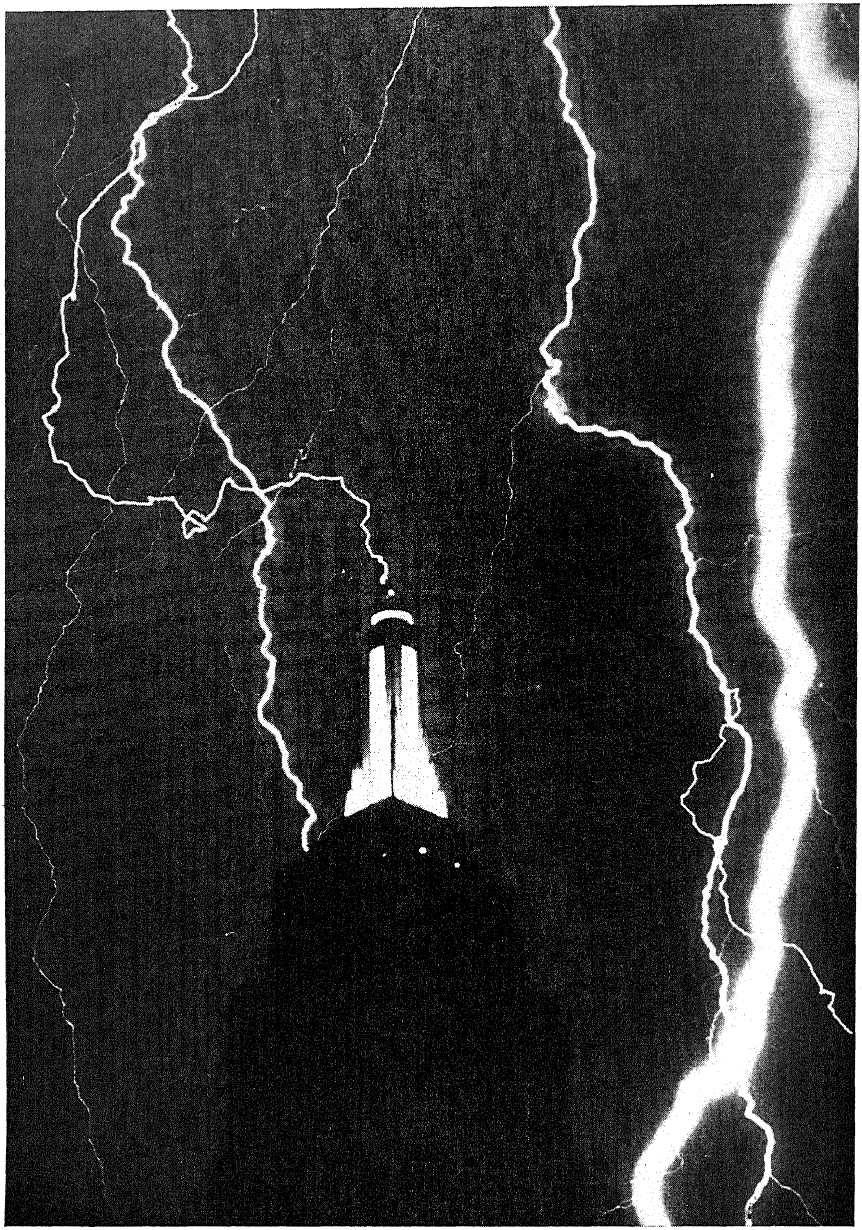


Fig. 286 Smoke Box photograph
showing bundle of rays entering model of eye rendered defective by simulated corneal opacities. No image formed upon retina. Exposure as in Fig. 284

At the conclusion of this work literally hundreds of feet of Leica film were on hand. These were scrutinized carefully, the best ones chosen, classified, viewed through the enlarger. Test prints were made, and unessential portions of photographs masked out.

Glossy 5 x 7 prints, ferrotyped, were made of all photographs desired for the motion picture work. They were uniform in size, finish, all were arranged and centered correctly. Mounted upon a special easel these prints were photographed with the Simplex Pockette camera in such a way that the white borders did not show.

When these "stills" were subsequently projected on a 7 x 9 foot screen they appeared amazingly life-like, brilliant and possessing all the roundness and detail that could be desired. What is more, as far as showing anterior segments was concerned, these stills had many advantages over actual direct shots: each eye stood still, as if caught and stopped; it was wide open for leisurely examination and observation of its defects and details. There was no contraction of the iris, no movement of eye-lids to obscure portions of the eye-ball, there was no visible trace of effort on the part of the patient to show it, no lacrimation nor discoloration, which usually are caused by prolonged examination of the eye.



Lightning Striking Empire State — John P. Gaty

Elmar 90mm lens, Time Exposure at f:4, DuPont Infra-D film, Wratten C and F filters

INFRA-RED PHOTOGRAPHY

JOHN P. GATY

CHAPTER 22

Photography by means of light beyond the ends of the visible spectrum offers many interesting possibilities to the experimenter. Ultra-violet photography, using shorter wave lengths than those transmitted by optical glass, requires expensive quartz lenses and filters which are not available to the average photographer. The invisible light of the extreme red and infra-red region, which consists of longer wave lengths than the visible red light, can be utilized for photography without the aid of expensive auxiliary equipment. A minimum investment in this type of experiment would be the purchase of a roll of infra-red sensitive film and a red gelatine filter. The ordinary Leica lens of any type will work perfectly, although the Elmar series should be set at a scale reading of 100 feet in order to focus the infra-red rays from distant objects. The Hektor series requires slightly less compensation, while the latest Summar lens is provided with a special index mark on the mount for the purpose of focusing with infra-red.

If close-ups are required, adjust the lens to the true distance and then subtract the same amount of angular rotation as was required to move the lens from the true infinity position to the selected infra-red infinity position. This amount of angular rotation is measured on the circular edge of the focusing ring. In all cases the infra-red scale-reading will be less than the panchromatic scale-reading, by a very slight amount. Images formed by infra-red rays focus slightly further back of the focal plane formed by visible light. To compensate for this generally slight difference, the lens should be racked out by something like 1/200 of its focal length. Thus, if a 50mm lens is used for infra-red photography, it should be racked out about ¼mm. In most cases the correction for close-ups is unnecessary, due to the depth of focus of the lens.

It is rather difficult to visualize the nature of infra-red rays. The fact that the word *red* is made part of its name should not be taken to imply that these rays are colored red. The name of these rays implies merely that they can be located in the spectroscope in the

region adjoining red. Because the human eye is not sensitive to infra-red rays it should not be even taken as *light*. They can be most accurately described as invisible rays. It is quite possible to describe infra-red rays as heat rays.

The use of infra-red light for photography is not new. Almost one hundred years ago Herschel made infra-red photographs by indirect methods which are still used to explore the infra-red regions beyond the range of response of our most modern emulsions. Herschel discovered that an emulsion which has been exposed to blue light will show a diminution of exposure wherever it is exposed to red or infra-red rays. A film which has been uniformly fogged by blue light will then show a *positive image* of a subsequently made infra-red exposure, when it is developed. Patience and careful control are required to make this system work effectively, but it offers great possibilities for research in regions otherwise beyond the reach of photography.

Infra-Red Films

Modern infra-red photography dates from about 1910 when the experiments of Professor R. W. Wood were announced to world famous scientific organizations. For a time popular interest lagged, due to the difficulty of obtaining suitable emulsions. Recently, great progress toward perfection of infra-red sensitive materials has brought the amateur photographer stable and fairly sensitive emulsions suitable for the purpose. **Those available for the Leica are Agfa R film, DuPont Infra-D film and Eastman K film.** The DuPont Infra-D and the Agfa R films are especially spooled for the Leica and are available from all dealers.

It is extremely important to use, whenever possible, extremely fresh material that is sensitized to infra-red light. Fresh films will be found more sensitive than old. It loses its sensitivity in a comparatively short time. **Infra-red film six months old is generally half of its original speed at the time of production.** It is therefore recommended that infra-red film be secured with an indication as to when it was produced at the factory.

The special applications of infra-red photography depend on two main characteristics of infra-red light. *First:* it has unusual power of penetration of atmospheric haze and certain materials which are opaque to visible light. *Second:* many substances show a reflective power to infra-red light which has no apparent relation to their reflective power to visible light. The full range of wave lengths of infra-red light is considered to be about *three thousand*

times as great as the full range of the total visible spectrum from violet to deep red. In other words, if the total visible color spectrum were considered as a piano keyboard, with each note representing a different wavelength band, or color, it would take a piano with three thousand progressively arranged keyboards to contain all the notes or colors in the infra-red spectrum. Photographically, only the very beginning of this composite *keyboard* has been explored to date, since most experimenters have failed to reach further than the top of the fourth standard *keyboard* length above the visible spectrum. The films already listed reach approximately to the top of the first standard *keyboard* length above the end of the visible spectrum, but in this region alone there lies a complete gamut of invisible colors (if such a thing can be). Since these cannot be seen, their effect on the infra-red sensitive film must be determined by experiment.

For illustration: some black, green, olive, blue, and violet dyes will photograph as light gray or almost white under certain wavelengths of infra-red light. Other dyes matching exactly in *visible color* will photograph by the same light as dead black or dark gray. This fact may lead to adoption of specialized infra-red and heat reflecting dyes for summer clothing. The cloth would appear to be dark to the eye and would not soil readily, but would be as cool to wear as a white garment.

Differences in Infra-Red Values

These two fundamental characteristics of atmospheric penetration and unusual tonal response are the causes of the peculiar effects depicted in landscapes when they are photographed by infra-red light. On a clear day there is a total lack of *atmospheric perspective,* or the demarcation of various planes in the distance due to the separation of tones by atmospheric haze. The foliage of most trees reflects infra-red light perfectly and the sunlit trees appear in the photograph to be covered with silver leaves. This effect is greater in the case of broad-leaved trees than it is with the firs, pine trees and hemlocks. Since the infra-red light penetrates the atmosphere without much scattering, that part of the spectrum comes directly down from the sun without illuminating the sky by diffusion. The sky shows a total lack of scattered infra-red light and thus appears as dead black unless it contains clouds or atmospheric vapor of a tangible kind. Since the sky is free of diffused infra-red light it cannot act as a source of light to illuminate the shadows of the scene. The shadows will therefore photograph as dead black, unless some object on the ground acts as a reflector. White sand or a green lawn will do this,

and the point should be remembered when attempting to compose a landscape. The infra-red pictorialist must think in infra-red photographic values only. Otherwise, his pictures will provide surprises continually.

The haze penetrating power of infra-red light has produced some remarkable results in aerial photography, but a distinction should be drawn between atmospheric haze, or intangible particles of moisture suspended in air, and actual clouds composed of water drops large enough to wet a surface passing through them. Clouds perfectly reflect all the photographically available wave lengths of infra-red light and it is obvious therefore that photographs cannot be made *through* clouds by infra-red light. It is unsafe to say that at some future time an emulsion will not be produced to record spectrums of unknown bands of infra-red and thus perform accomplishments now impossible. Present research, however, has shown that the first *keyboard* of the infra-red above the visible spectrum is the most useful for haze penetration. At the lower end of this range, near the visible light, a 1½ inch layer of distilled water is almost completely transparent, while at the upper end it absorbs about 90 per cent of the light directed upon it. There is a slight decrease in absorption of light near the beginning of the second *keyboard* and then a rapid increase, until at the upper end and thenceforth to the limits of exploration the water is completely opaque. This interesting fact explains the surface heating of large bodies of water in summer since the longer wave lengths of infra-red are intimately associated with heat. It also explains why a drop in temperature is felt when a cloud passes across the face of the sun. The infra-red and heat waves are reflected back into space or absorbed by the cloud and cannot reach the earth. Since heavy fogs are simply clouds at rest on the ground, there does not seem to be much hope for the so-called *fog cameras.* The type of atmospheric haze and light mist penetrable by photographically available infra-red light hardly offers a serious menace to navigation.

The penetrating power of infra-red light is selective. Some woods such as certain pines, sycamore, balsa and beech transmit infra-red freely through layers up to ⅛ inch. Other woods of the same thickness, such as teak, oak and walnut transmit little or no infra-red light. Rubber is a material that is a good transmitter of infra-red.

Human skin transmits infra-red light to such an extent that certain limited medical applications have been found for this type of photography. Subsurface details that are invisible to the eye sometimes can be seen in an infra-red photograph. This fact makes infra-red portraiture disappointing, since the subject always appears unnatural. A man's clean-shaven face often photographs as though heavily bearded with stubble, and the natural facial contours are changed in appearance.

Infra-red photography is very effectively being employed in the field of medical research. Remarkably clear images of subcutaneous structures of blood vessels appear clearly when photographed upon

infra-red film either through a filter placed upon a lens or with filters placed upon the light source. Very interesting photographs have been made of the development of varicose veins long before they were apparent to the naked eye. In the field of dermatology the application of infra-red photography should be of particularly great interest: certain skin diseases result in a crust-like coating of the skin which does not permit an observation of the condition of tissues beneath the crust. Photographs on infra-red film would reveal the condition of tissues and cells beneath that crust with comparative simplicity.

Infra-red portraiture sometimes can be applied to people with unusual skin defects which may actually disappear in the photograph. Deeply pigmented skin often appears white when taken upon infra-red film.

In the field of criminology infra-red photography repeatedly has proved its ability to differentiate between pigments which were visually the same in altered documents or forgeries. There also have been cases where paintings photographed by infra-red light revealed the presence of lower layers of paint constituting a different picture. Extremely interesting results had been obtained by the use of infra-red photography for revealing detail in old documents, which were either stained or deliberately deleted by censors with black inks. The same applies to faded inks, fabrics, records or parchment, wood and leather. One of the many available methods of examining and testing paintings of old masters consists of photographing those paintings on infra-red film, which will reveal the slightest traces of lower layers of paint. It is sometimes possible to read a letter in a sealed envelope by photographing it on infra-red film through the envelope from both sides and subsequently arranging the different aspects for legibility.

In photomicrography interesting experiments have shown that infra-red light is capable of revealing hidden details of structure. This application is a recent one and offers considerable possibilities for experimentation. It depends on the property of infra-red rays to penetrate certain substances while being reflected by others, quite at variance with the action of visible light. It is successfully employed in rendering invisible details of cell structures beneath the outer covering of insects' bodies which is composed of a substance known as chitin. It is frequently found that a black or dark colored beetle or insect just as easily can be *trans-illuminated* with the aid of infra-red rays as a wing of a grasshopper with ordinary light.

Infra-red photographs through a miscroscope are not by any means easy nor simple because of the extremely small depth of focus available at such great magnifications. The infra-red rays focus in a different plane from that of visible light, and it is almost impossible to make the two foci coincide. One has to take several exposures with different settings of the indicator of the micrometric adjustment of the microscope and after developing and examining the film determine which is the correct setting for a given exposure.

Celestial photographs by the aid of infra-red have shown details of planets which otherwise were veiled by the planets' own atmosphere, and have depicted stars beyond some of the nebulae. Here, again, the exceptional penetrating power of the rays is of advantage.

One of the most popular applications of infra-red photography was developed in the Hollywood studios for securing night scenes and moonlight effects in broad daylight. As previously mentioned, blue skies are rendered black when photographed on infra-red film. Thus, if a photograph be taken on a clear, cloudless day, the landscape would show a black sky. Considerable experimentation must precede any definite application of infra-red film to such effects.

Exposure and Filters

The standard exposure with the Leica and the films mentioned in this article should be from 1/10 to 1/20 at f:3.5, when using a filter of a density approximately a Wratten No. 25 (cherry red).

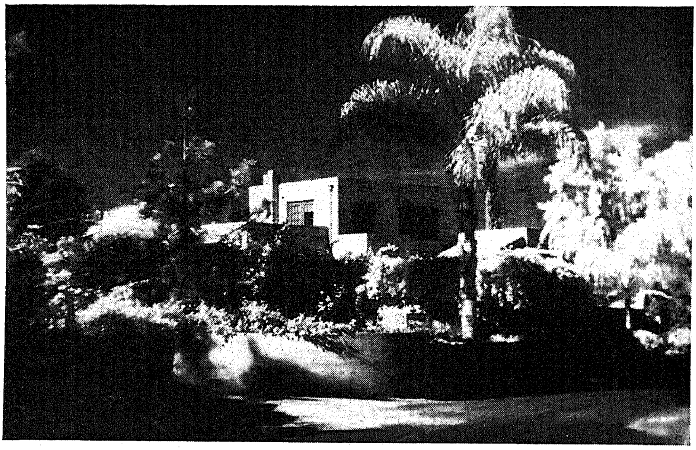


Fig. 288 California Sunshine John P. Gaty

Hektor 50mm lens, 1/20 second at f:2.5, DuPont Infra-D film. F Filter. (Note reflection into shadows of upper part of house from roof below)

These exposures are for a bright, clear day in full sunlight. It is impossible to set up a standard for a cloudy day, since experiments have shown that the infra-red light intensity seems to have little relation to the intensity of the visible light, as measured by an ordinary photometer. It may be proportionally more or less, perhaps depending on the *wetness* or particle size of the water vapor in the clouds. The only method of determining proper exposures under artificial lighting is by experimenting with the light source used.

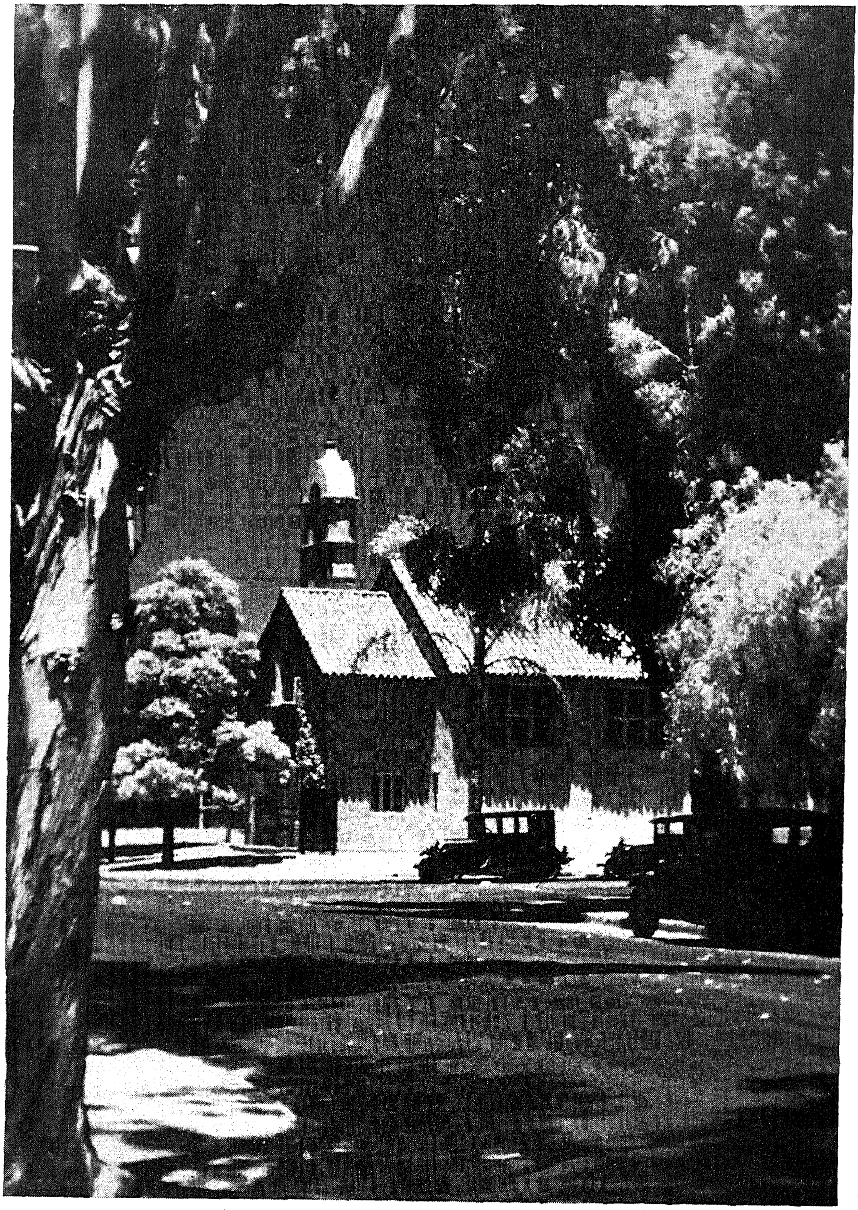
Fig. 289 California Landscape John P. Gaty

Summar 50mm lens. 1/20 second at f:2.2, DuPont Infra-D film, Wratten F filter (Clouds are not printed in nor retouched. Infra-Red always renders clouds unusually well)

Under-exposures should be avoided at all times. It is best to always give a full exposure and thus provide a margin of safety for low density development. The resulting negative will show less grain and will possess better shadow detail, although the shadows must depend for their illumination upon reflective surfaces.

Combinations of gelatine filters can be used for selecting the longer wave lengths of infra-red and the exclusion of most of the extreme visible red. Such combinations could be a No. 29 (F) Wratten gelatine plus either a No. 45H, a No. 46, or any of the C series of blue Wratten gelatines. Study of the absorption curves in the Wratten filter book will suggest other combinations.

A very interesting special application of infra-red to landscape photography is to enlarge the photograph and tone the enlargement blue. If properly composed and toned, the photograph will then show white clouds against a deep blue sky, white trees and grass, and various gray tones for buildings and pavements. The addition of oil coloring to the trees and



California Church

John P. Gaty

Summar 50mm lens, 1/20 second at f:2.3, DuPont Infra-D film, Wratten F filter. (Note shadow detail, aided by reflection from sidewalk)

grass and other parts of the picture will produce a surprisingly good imitation of a natural color photograph. The light tones of the foliage and buildings allow the colors to stand out with a brilliance never found on an ordinary oil tinted photograph where the colors must be laid over fairly dark gray areas. The sky is natural and the clouds possess all the detail that they should, and not the unnatural indefinite appearance found in the usual tinted photograph. The shadows must be selected carefully in the composition and if not too deep, their bluish tone will add naturalness to the result. The stunt is well worth trying.

Hypersensitizing the Film

If the film is too slow for action photographs it can be speeded up by hypersensitizing either by borax or ammonia. An increase of 100% in speed can be expected.

Borax Formula

At 12° C. or 50° F.:
- **0.5 gram sodium chloride**
- **2 to 3 grams borax**
- **1000 cc water (preferably distilled)**

Immerse 2 to 6 minutes, don't rinse, soak in methyl alcohol 1 minute, dry as quickly as possible after removing surface fluid.

Ammonia Formula

At 10-12° C. or 50° F.:
- **2 cc Ammonia (0.91 sp. gravity)**
- **275 cc Alcohol**
- **725 cc water (preferably distilled)**

Immerse 2 minutes, don't rinse, dry as quickly as possible after removing surface fluid.

Above treatment must be done in complete darkness.

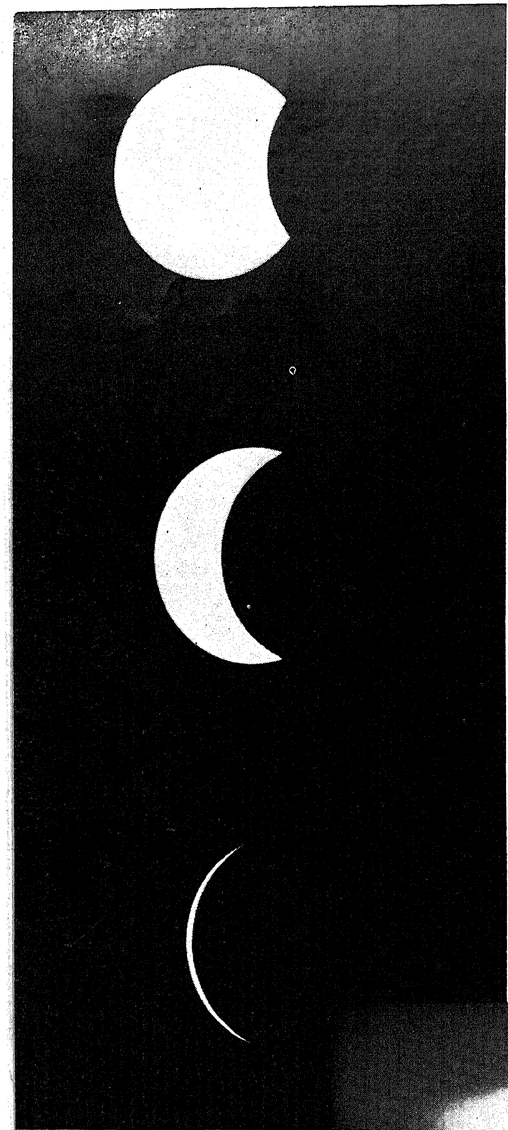
After hypersensitizing, the film should be used as soon as possible. If necessary, it can be kept a few days in an ice box without deterioration. Before it is loaded in the camera, the film should be allowed to warm up to room temperature so that condensation of moisture on its surface may be eliminated.

It should be stated at this time that some of the effects obtainable with infra-red filters are not confined to film specially sensitized to infra-red rays such as were mentioned before. Any good panchromatic (red sensitive) film will in a greater or lesser degree enable the application of a red filter and sometimes will yield results comparable to those confined to pure infra-red photography.

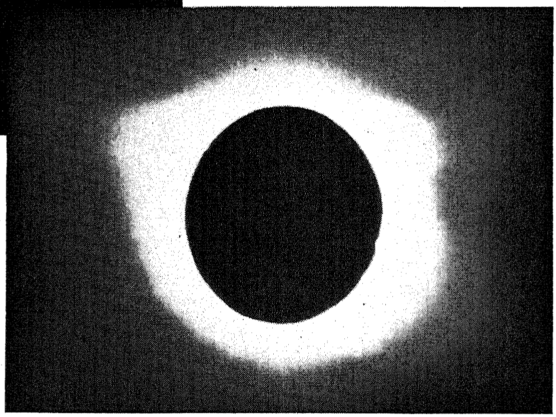
The field of infra-red photography lies open, with boundless possibilities for original experimentation. There are chances to do serious investigation as well as to produce interesting and striking photographs. They constitute a challenge to the inquisitive and original photographer.

Fig. 291 Phases of Total Eclipse of the Sun

Photos by Lincoln K. Davis



With 24-inch lens on Leica Camera. Partial phases taken through E. K. neutral filter, exposure f:32, 1/200 second



Taken at Truro, Mass., August 31, 1932

ASTRONOMICAL PHOTOGRAPHY WITH THE LEICA

LINCOLN K. DAVIS **CHAPTER 23**

The remarkable versatility of the Leica makes possible many uses for which it was not particularly designed, and its employment in work to which other cameras are not adapted, or are at a disadvantage on account of weight, size, construction, etc. The combination of a focal plane shutter and a readily demountable lens in a camera using a small film invites the use of various lenses, especially those of long focal length, as these features together offer certain advantages with such lenses.

During the summer of 1932 I became interested in photographing the total eclipse of the sun which came in August of that year. Here was a fine opportunity to try the Leica with a long focus objective. The standard 50 mm. Elmar gives an image of the sun which is practically microscopic, and even with a film of very fine grain, really good enlargements are impossible. Therefore, a long focus lens is essential in order to obtain an image big enough to enlarge successfully, without too much graininess or loss of detail.

Hunting around, I came across just the lens I was looking for in the form of the objective of a thirty-power collapsible telescope. Its focal length turned out to be 24 inches, full aperture f:13, and it gave a very sharp image, covering the Leica frame without appreciable marginal loss of definition. The sun's image was about a fifth of an inch in diameter, not very large, to be sure, but plenty big enough to allow enlarging to fill a five-by-seven print. By means of a mailing tube and two pieces of brass tubing fitting it snugly, one threaded for the lens and slideable for focusing, and the other threaded to fit the lens flange of the Leica, a compact and light telephoto outfit was made, well adapted to the taking of the eclipse, as the results proved. A wire frame type finder was attached to the tube, and the latter fastened to a wood base having a tripod socket. The inside of the tube was painted a dead black.

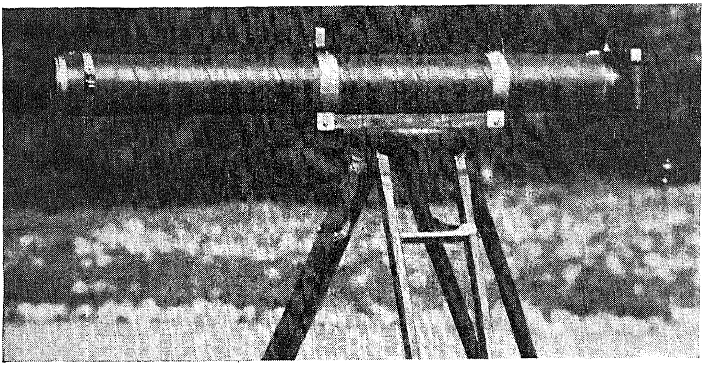


Fig. 292 Leica Mounted on Tube with 24 inch lens for Long Distance Pictures

The partial phases of the eclipse were exposed through a neutral filter having a factor of about 32,000 times, time 1/200 second, with a cardboard stop to close the lens opening to f:32. Five exposures of the total phase were taken, ranging from ¼ second to 5 seconds, at f:13. The accompanying cut is taken from the 2 second negative. Perutz Leica film was used. The ease and speed of operation of the Leica was never more appreciated than during totality, which lasted only 61 seconds, for I was able to take five time exposures, and yet have left a half minute to look at this most impressive of all spectacles. All of the negatives were extremely sharp and enlarged readily eight or ten diameters, and even a twenty-diameter enlargement was quite good. An astronomer acquaintance of mine, who had himself obtained some excellent photographs, asked me if the eight-times enlargements I showed him were contact prints!

My camera is also well suited for long-range terrestrial photography, producing as it does an image twelve times as large as that of the usual 50mm lens of the Leica, and its total weight of only three pounds means that it may be held readily in the hands and aimed like a rifle. For the usual work, however, a tripod is almost essential, unless the lighting conditions permit a high shutter speed, as every movement of the camera is magnified likewise twelve times. Precise focusing is also very important with long focal lengths, as the depth of focus is extremely limited, even at small stops. For example, the 24-inch lens, stopped down to f:32, has no more depth than a 6-inch lens working at f:2. A focusing scale is therefore not satisfactory for anything much inside of infinity focus, unless distances are known accurately, so a sliding ground glass adapter for

the Leica, with a magnifier, is really necessary for the best results. The one that I use is home-made, but it does the work.

Photographing Through a Telescope

Shortly after the eclipse I tried some pictures of the full moon, and did get a few fairly good ones, using an exposure of 1/20 second, stop f:13. However, the image was hardly big enough to show much detail in the enlargements, and I realized that if I was to obtain good results on the moon, I would need a still longer focal length, which meant a telescope. Having heard that telescope making was not beyond the capabilities of the average person who likes to make things, I got a copy of the excellent book on the subject published

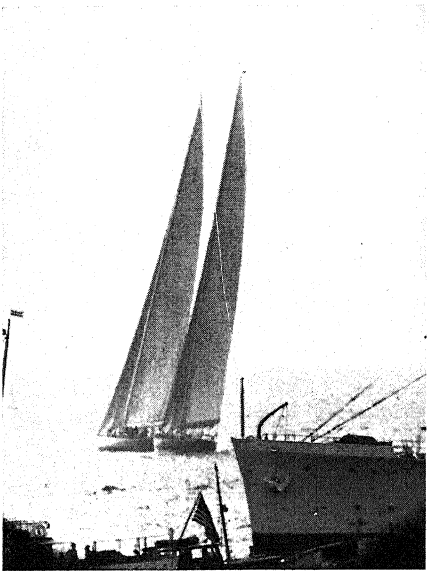


Fig. 293 Start of America's Cup Race, September 22, 1934. "Rainbow" at left, "Endeavour" at right, photographed from a distance of 5000 feet. Taken with 24" lens, 1/100 second at f:13

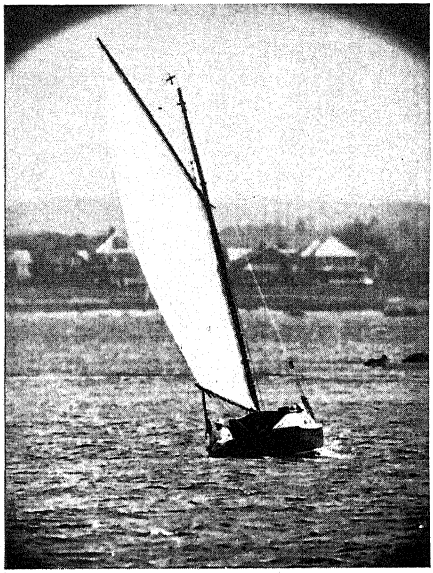


Fig. 294 Boat three-quarters of a mile away. Taken with the telescope

by the *Scientific American*, and during the following winter built a 6 inch of the reflector type. This has a focal length of 50 inches, and thus produces an image twenty-five times as large as does the Elmar. The Leica may be substituted for the eyepiece, as shown, or by means of a special enlarging camera with a long bellows draw, which uses the Elmar to enlarge the primary image, much the same as in taking enlarged photographs of small objects, the equivalent focal

length may be extended to as much as thirty feet. A ten-diameter enlargement of a negative taken with the maximum magnification can thus give an image equal in size to that made by a lens of three hundred feet focal length. Practically, such a high power can seldom be used, principally on account of unsteadiness in the atmosphere during the necessary exposure of several seconds, when taking either the moon or a landscape. However, there is usually no difficulty from this source when supplementary magnification is not used, that is, when the camera is placed at the primary focus of 50 inches, for the exposure then may be instantaneous.

The boat shown in the accompanying photograph was three-quarters of a mile away, the camera being at the 50 inches focus, exposure 1/200 second, stop f:8.3. Notice that the distant shore, three miles away, is badly out of focus, showing how limited is the depth of field at this focal length and aperture, in spite of the distance of the object.

The series of three pictures of the same distant house gives a good idea of what can be done with the telescope. The first was taken with the 2 inch Elmar, the second with the 50 inch mirror of the telescope, and the third with the 50 inch mirror plus a seven-times magnification, using the Elmar as described above. The magnification represented is, respectively, one, twenty-five, and one hundred and seventy-five times. The first two were taken at 1/100 second and are very sharp; the third required an exposure of about a half-second, and shows the slight blurring caused by wavering of the air during even this short exposure.

It may at first seem strange that a simple two-element achromatic lens, or, in the case of the mirror, a single optical surface, can produce an image equal in definition to that made by a highly corrected photographic objective having four or more elements. In fact, such a

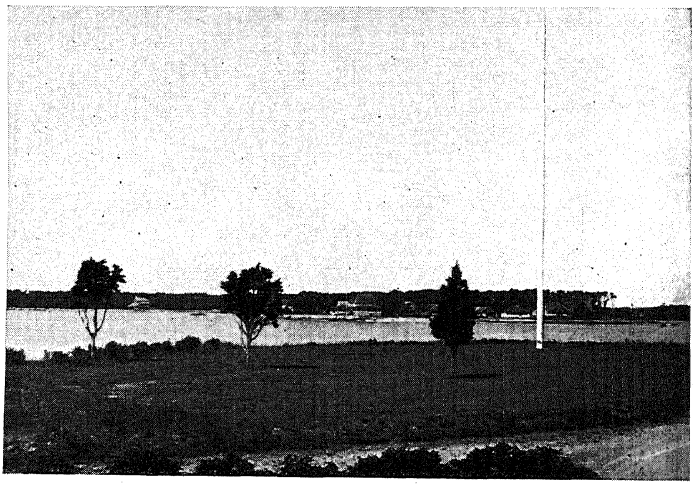


Fig. 295 View taken with Elmar 50mm f:3.5 Lens

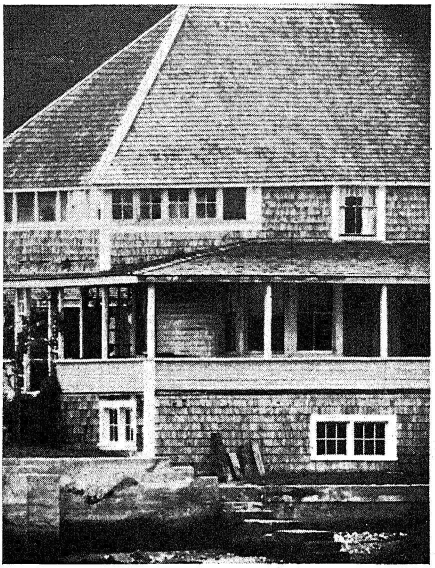


Fig. 296 Same view as Fig. 295. Taken with telescope of 50 inches focal length

Fig. 297 Same view as Fig. 296 taken with 50 inch telescope and the 50mm Elmar lens to magnify primary image 7 times

lens or mirror, if good enough for astronomical use, is capable of an image sharpness which surpasses that of the best lenses intended for photography. However, there is a catch, and it is this: an astronomical objective, either lens or mirror, is required to create an image of exquisite sharpness, but only over a very narrow angle. When using a high-power eyepiece, this angle may be as little as eight or ten minutes of arc, but the definition must be such that the image can be magnified fifty or more times without "breaking down". Thus it does not matter if the image is rather bad at a few degrees from the optical axis, provided that the sharpness is satisfactory on or very close to the center line.

On the other hand, a good photographic objective must cover an angle of upwards of forty-five degrees, with a sharpness such that the limit of definition is set by the emulsion used and not by the lens. This means that some of the central sharpness has to be sacrificed in order that the margins of the field may be covered with tolerable sharpness. So while the axial definition of an astronomical lens or mirror is superior to that of a camera lens, it is equally inferior a

few degrees from the center. Therefore, when the required sharp field subtends a small angle at the lens, or stated another way, is small in diameter compared with the focal length of the objective, the sharpness of the central image becomes the important consideration, and a lack of definition at a large angle to the optical axis does not matter. This is why the Leica, with its small film, works so well with a simple achromatic lens or with a mirror having a focal length of two feet or more, so that only that part of the image on and near the optical axis is used, where the definition is at its best. Of course, a larger camera could be used, but the great advantage of the Leica

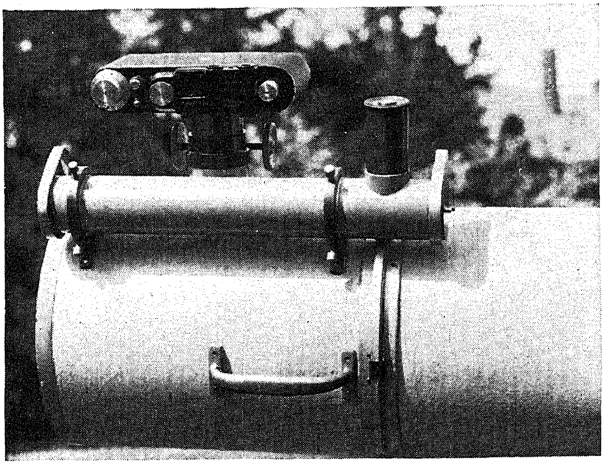


Fig. 298 Leica Mounted on Eyepiece of the Telescope

is the fact that the focal length of the objective used with it may be many times the diagonal of the film, to give a high magnification and at the same time good definition, without the outfit becoming too large and cumbersome to be practical.

If a telescope from which the lens may be borrowed is not at hand, such a lens may be obtained from a dealer in telescopes and optical supplies, at a price ranging from five dollars upwards, depending on the quality. A lens which is only fairly good, judged by astronomical standards, will be found to give excellent results when used in the way described above, so it need not be expensive. The best and least costly way to obtain a fine objective for telephoto use is to make a telescope mirror. A six-inch is not hard to make, and need not be elaborately mounted in order to permit interesting experiments with photography, as well as observing many wonders in the heavens. But telescope making is a story in itself.

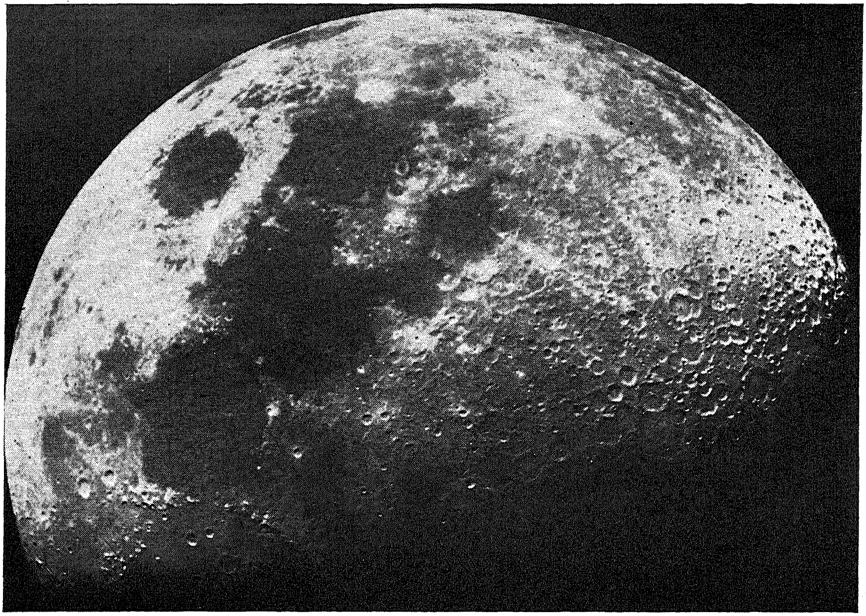


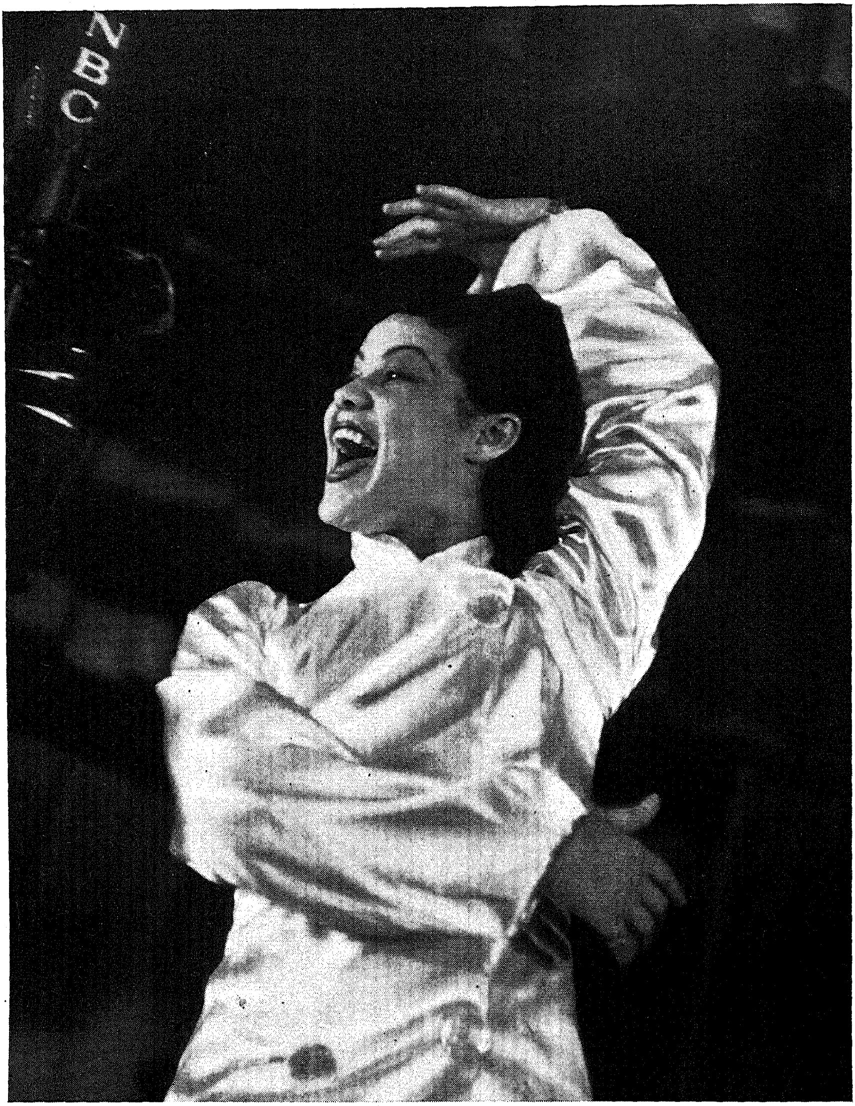
Fig. 299 Moon...Feb. 11, 1935 F. W. Schlesinger

Leica on Telescope, Focal length, 147 inches, Perutz Neo-Persenso, K2 filter, 10 seconds at f:15.

Mr. Schlesinger writes about this photograph as follows:

We have two telescopes here (The Franklin Institute of the State of Pennsylvania, Philadelphia) in the Astronomical Section of the Museum: a 10 inch Zeiss Refractor and a 24 inch Reflector by Fecher of Pittsburgh. We have been doing some astronomical photography with them, and I have tried some with the Leica, especially with the Refractor. The focal length of this instrument is 147 inches, and I have attached the camera so that the image is formed on the film without any eyepiece or camera lens intervening. Planetary images are too small, while the image of the moon is just barely too large for the frame of the camera. The reflector would be more satisfactory since it can be used at focal lengths of either 125 inches or 350 inches. I have been trying the Micro-Ibso attachment on the Refractor with fair results on the moon, and am sending you some prints of "lunar landscapes". Some of these prints are made with a 10x Eyepiece, Pan Film and a K2 Filter. The *f* value of the telescope is 14.7, exposures ran from 5 to 20 seconds.

As soon as the Reflector is available I expect to get some really fine pictures with this attachment, since this instrument has an *f* value of 4.5 and is, of course, perfectly achromatic, so that I can dispense with the filter. This will permit exposures from 1/10 of a second up. A shorter exposure is of great advantage in getting a sharp image, since it cuts down the motion of the image due to "bad seeing" or the unsteadiness of the atmosphere.



N. T. G. Girl Rudolf H. Hoffmann

Hoffmann by Dmitri

RUDOLF H. HOFFMANN

CHAPTER 24

CANDID PHOTOGRAPHY WITH A LEICA

Although Mr. Webster defines the word *candid* as: *sincere, frank, impartial, fair, aboveboard, innocent, honest, truthful, unbiased,* and a lot more, this short word in the vocabulary of a camera man has come to mean something else. The term is associated with photographs representing a record of what the eye of an unobserved observer has observed. It is assumed that the camera is used so inconspicuously that it is in a position to record something that is intended to be actually *off the record.* Such is the pure and simple meaning of candid photography.

In a sense, candid pictures are perhaps the oldest style of photography, since the camera was invented before the airbrush and

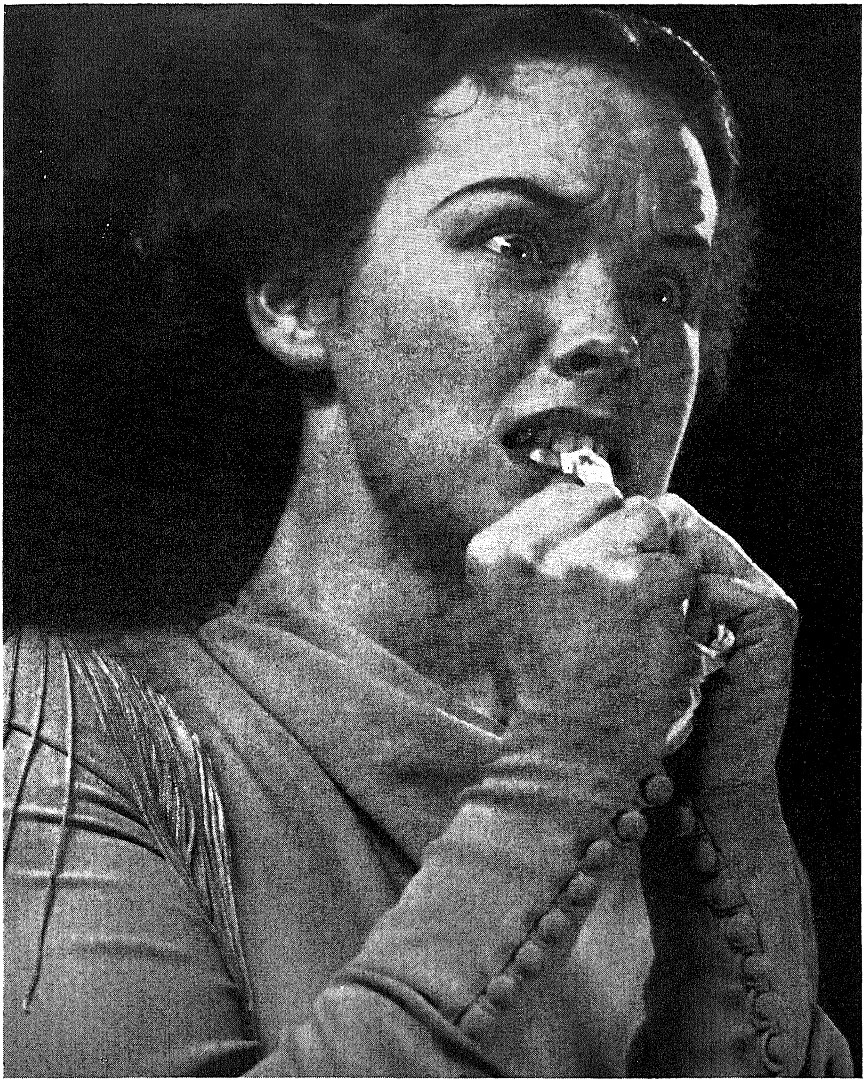
before the professional retoucher learned to transform his picture so that the subject would look like someone else.

From the above interpretation of *candid photography* it is obvious that the candid camera must have certain distinctive features to do this work. It must be very small, must have a very fast and sharp lens, a highly sensitive film and plenty of it, and must permit change of film in rapid succession.

I use a Leica camera because it meets these requirements and because I want pictures that do not look like the average photograph. Now don't misunderstand me when I say, not to look like a photograph: I do not mean that I expect the picture to look like an etching or a painting. I am thinking mainly about the subtle and elusive part of the record; I am thinking of that quick expression, that fleeting something in a person's action and expression which, though constantly changing, makes them what we know them to be. To catch the person's character, personality, to grasp that intangible lifelike likeness which is ever so abundantly present in a person in action and so conspicuously missing in the same person seated in the studio facing a camera. That is what I mean by candid photography.

A great many of my assignments consist of getting photographs of prominent stars of the radio, screen and stage worlds. Most of my clients are editors of well known national magazines and advertising managers. They are business men, and true to form they always look for something new for their public. Their files are bursting with hundreds of pictures of these stars, but most of them look more or less alike. Reason: they were all taken according to one patent formula, "Look this way, please, smile, hold it, click...Thank you, that's all." And the photograph is just that. For this reason, these business men recognize the value of pictures of these same stars showing them as human beings rather than as dummies, showing them as the public sees them rather than as they themselves or their photographers would like them to appear. Candid photography requires an appreciation of art and composition. Proceeding with the subject in the manner diametrically opposite to the patent formula mentioned above, the candid camera man does not direct the action or behavior of a subject, but permits the person to be himself, and observing a most characteristic or revealing pose, full of expression and personality, snaps it there and then.

We come into the room, or studio, or stage, where the artist is at work. He or she may know or may not know that a photograph is to



Horror Rudolf Hoffmann

be taken. We observe the available lighting, we select the proper lens, set it at the proper lens aperture, set the shutter speed, and if necessary ask the artist to take no notice of us. Then we look through the view finder, move into position which we think is most advantageous for obtaining interesting, story-telling composition. It may be that such a vantage point is the so-called *worm's eye view,* which will make us crawl on the floor. Then we focus, watching once again through the view finder for the fleeting expression, for that dramatic action, for that glamourous action...Click!...But not yet "Thank you"—that's only one shot. We wind the shutter...Click...Another expression, wind...Click...Wind...Click, click, click...We move to another place seeking a different composition, different lighting, we see our subject in profile...Click, click, click...We wait...Click... Someone in the room tells a joke...Our subject laughs naturally... Click, click...He lights a cigarette...Click, click...He is getting serious...Click, click click...Now he turns towards us and may ask, "are you ready to take my picture?" Click. "Thank you", we say, "we have thirty pictures of you now!"

If you are going to take candid photographs of people, you should study your subjects before you tell them that you specialize in this type of work. There are many persons who do not want a candid photograph taken of themselves. Some time ago I was asked to get candid photographs of a very famous actress who was getting along in years. When she found out that I was going to take candid photographs of her she stamped her foot and said, "I won't stand for it. I hate that nasty little camera, it tells the truth about me, all pictures of me must be retouched before my public sees them." Another actress threatened to cancel her contract because her publicity agent had released some candid camera shots of her without showing her the photographs first.

Yes, the candid camera does tell the truth, truth that sometimes hurts, but in most cases the editors of big circulation magazines and newspapers would rather have a candid picture than a stiff, posed, retouched photograph. The truth of it is that nearly every one likes to see a candid photograph of the other fellow but not one of himself. In other words we, ourselves, like to look like some other person. If we have a wart on our nose, or a harelip or deep wrinkles, puffy eyes, big stomachs, piggy eyes or horse ears, we expect the photographer to remove these things that nature has given us and substitute something else with his pencil or air brush.

Selfconsciousness and the Candid Camera Photographer

Above all a cameraman who wants to get good candid shots must rid himself of all selfconsciousness, all fear and stage-fright. Such lack of selfconsciousness grows out of practice and experience which is the prerequisite of everything one is supposed to do well. Though the candid cameraman frequently attracts attention this should not interfere with his aims. His position, his location and movements should be governed entirely by the picture he is after. His ability to move around quickly, inconspicuously, alertly following his sub-

Fig. 302 Kompa Sisters Willard D. Morgan
Summar 50mm lens, f:3.5, 1/500, Dupont Superior film.

ject, plays frequently as important a role in his assignment as his equipment. Never was a familiar expression as true and well taken as in this type of photographic work: "It's not the camera—it's the nut behind the button—that gets the picture".

And though frequently the difficulties of getting some of the candid shots are great, handicaps being placed in the cameraman's way seemingly by everybody, that cameraman will win and get the picture, whose personality and personal charm will win the hearts of those around him. Though the audience, the subjects, the managers,

Gloria Swanson

Stan Laurel

Oliver Hardy

Rudolf H. Hoffmann

(*left*) Marlene Dietrich

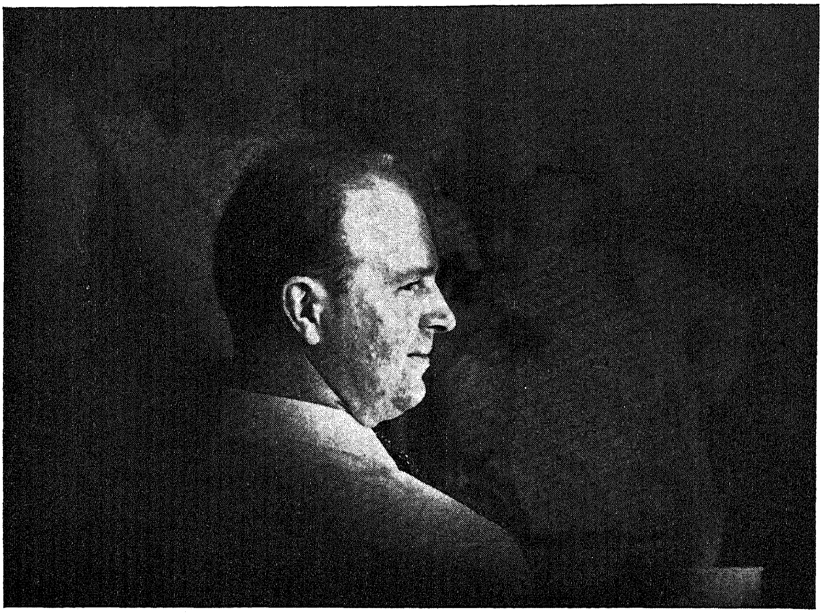
Katherine Hepburn

Zazu Pitts

Lupe Velez and her Impersonations

the stage-hands, the directors—all may feel that the cameraman is a nuisance—they will smile at him and give him a helping hand if he will win them with a smile, with a joke, with his ingenuity and a general amiability. But never will he get his picture with arrogance, impertinence and impudence. Remember: "The maid that smiles is half won!" Then smile at them—and make them smile!

A great deal of my work is done in broadcasting studios, taking candid photographs of famous actors, actresses, public men and women and people who are naturally nervous, irritable, temperamental



H. W. Zieler at Meeting of "Circle of Confusion" Harold Harvey

and naturally don't like to have candid pictures taken. My assignments call for from six to ten photographs that can be reproduced in newspapers and magazines. I have to get them as quickly as possible because in the minds of my subjects I am a nuisance. Each shot must be a masterpiece because my client does not care to what trouble or embarrassment I must go to get the picture. Everything is done in a hurry and to all appearances I am always in the way. I am upsetting things and everybody. Now and then I may get the use of additional lights, more often I am not allowed to make any

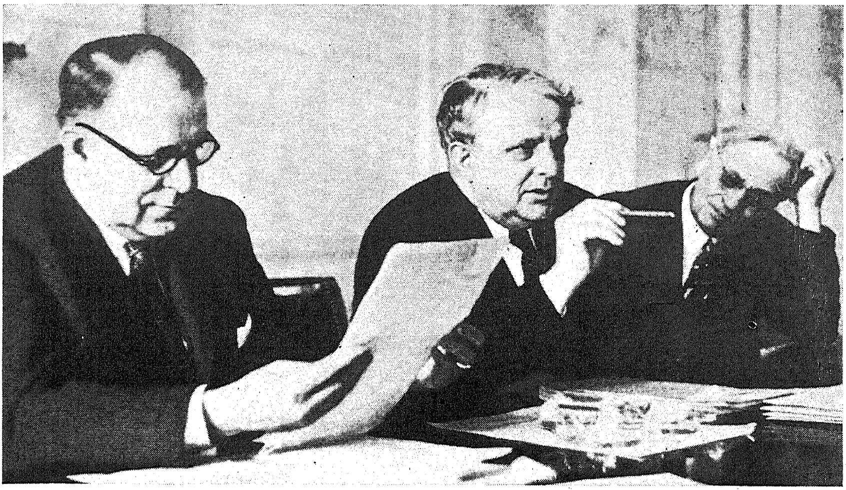


Fig. 305 Senators David Walsh and James J. Davis at Senate Inquiry into the "Kickback Racket". Photograph by Thos. D. McAvoy, Summar 50mm lens, 1/20 second at f:2.2, DuPont Superior film

changes whatever, for those changes annoy and distract the artists at the microphone. As a result of these experiences I frequently simply sit down in the studio in as inconspicuous a place as possible and start taking pictures before the artist knows that I am there. Sometimes I go into the control room and get my pictures while sitting behind the plate glass screen which separates the control room from the microphone. This is probably the most desirable way of photographing my temperamental subjects without their being aware of my presence at all.

Candid Photographs in Industry

One of the most fertile fields for interesting candid pictures is offered by industrial work. Insides of mills, factories, constructions, oil fields, marine life, ship building, places where men are working with heavy machinery, where men and women are doing things. There is plenty of action, plenty of sincerity and little self-consciousness. No matter how big or small, no matter how familiar or strange the product, the processes of its manufacture, its making from raw materials, its molding and shaping, and finishing and wrapping, all these stages are filled with interest and glamour to the onlooker. Wheels and machinery, conveyors in their everlasting movement in a certain direction, monstrous cranes moving heavy objects, the rhythmical movements of men, all of this will fascinate, and it will fascinate

other people too, if your pictures will tell the story the way you saw it. In this type of work you will often depend on whatever light is available, whether it be daylight or artificial light. You must place yourself in the most advantageous position to get the most out of available illumination. You must try several angles through your view finder. Avoid getting too many things in your picture. If the object is too large, take several pictures rather than crowd everything into one.

One must have fast lenses and fast film emulsions to get such pictures. But do not attempt to stop machinery in action in your pictures. For that matter, whirling wheels and other parts of machines will look much better that way and much more natural. Persuade the men at work to pay no attention to you but to proceed with their work as if you were not around. Otherwise your pictures will look posed and defeat their purpose.

Candid camera photography is not confined to the various types of work described. Hunting with a candid camera is as full of thrills as hunting with a rifle. It differs from the latter in that your trophies are alive. Every one is looking for a thrill in life; some turn to golf, some to hunting, others to fishing. Teddy Roosevelt went to Africa with a big game rifle. Martin and Osa Johnson went to the same place with a camera. We can't all go to Africa with a camera

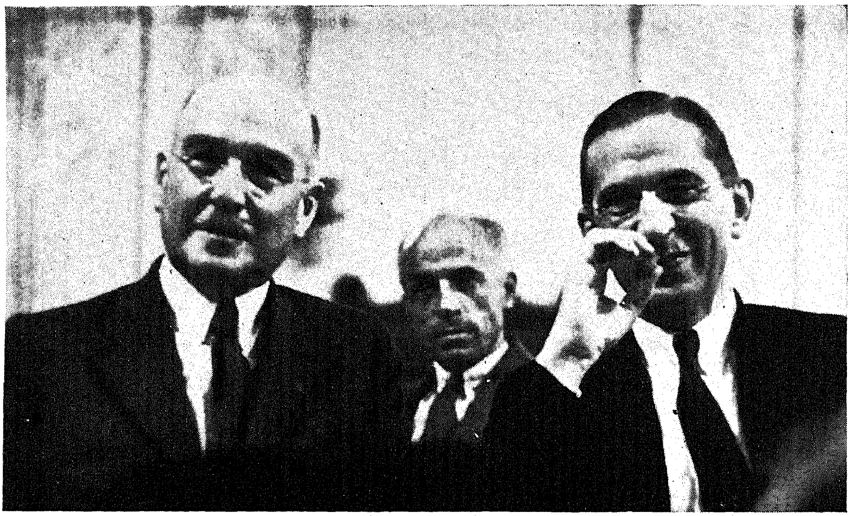


Fig. 306 Pierre and Lamont DuPont at the Senate Munitions Hearing. Photograph by Thos. D. McAvoy, Summar 50mm lens at f:2.2, DuPont Superior film

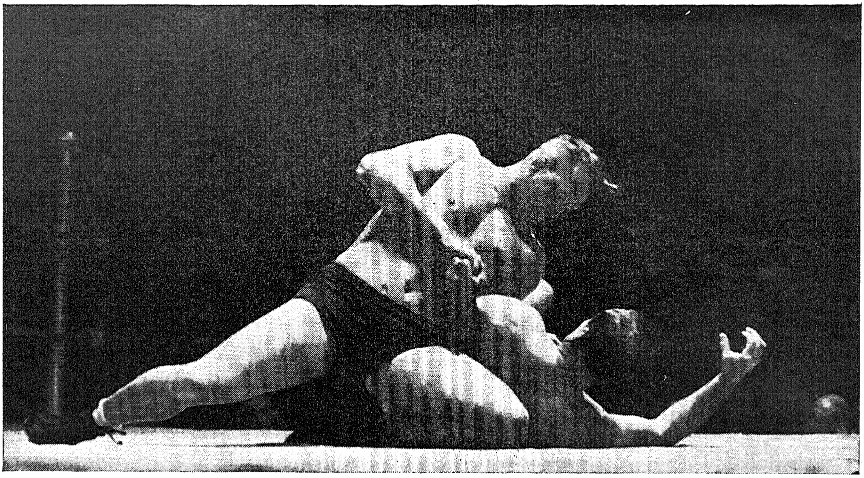


Fig. 307 Wrestlers Charles H. Fink

but with the candid variety in hand lots of us are getting plenty of thrills right in our own home recording interesting things going on about us.

The truer to life our pictures, the greater thrill we get out of them. And it seems that the candid camera *par excellence* is the small camera, such as the Leica camera, because it can so easily become a part of you, your third eye.

Candid shots are seldom taken with a tripod or with time exposure, for one must move about with the subject or squat down on the floor, lie on one's back, climb up on the piano, sometimes even hang from the chandelier, if one wants to get candid pictures. And how can you hang on to a railing while carrying a tripod, looking through a ground glass, slip in your film pack, snap the shutter, and get a picture besides?

Many a professional or amateur photographer has gained fame and acclaim because of some unusual candid photographs secured in the tense atmosphere of a famous trial. Cameras are officially not admitted to courtrooms of some trials, the judge having the final word in the matter. Still some people take the chance, holding their little camera in the folds of their sleeve, or under their coat, they get the picture they want. And some of them are priceless, indeed. Though you may not know the principals of the affair from the picture, nowhere else is it possible to secure such a magnificent record of human emotions displayed on faces as in the courtroom.

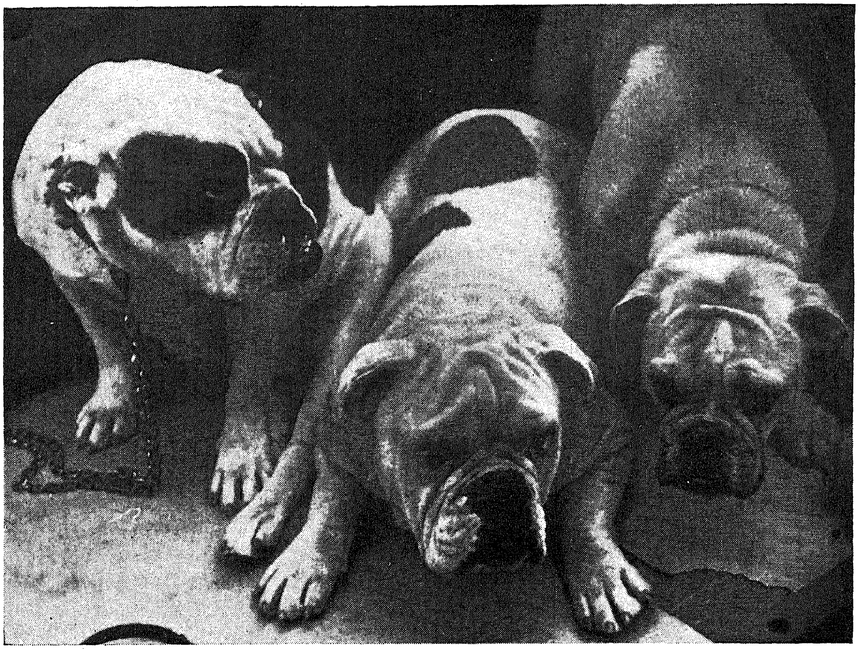


Fig. 308 Pugs Ivan Dmitri

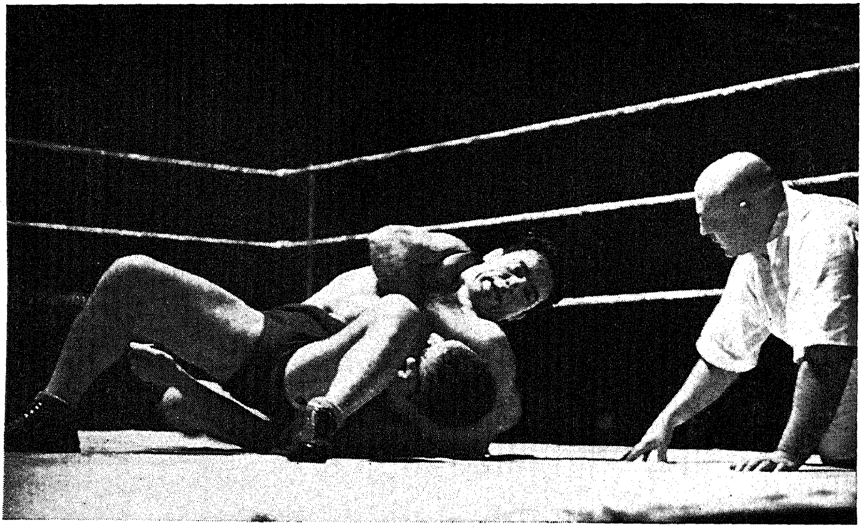


Fig. 309 Jim Londos, world's champion wrestler with head lock on Dick Steele (Pete Sauer) at the Auditorium, Memphis, Tenn. on December 23, 1934, Charlie Pentrop, referee. Photo by Joseph J. Steinmetz.
Summar 50mm lens, 1/20 second at f:2, Agfa Superpan film

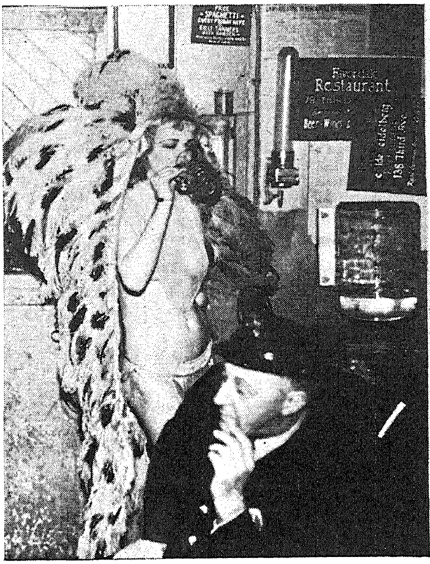


Fig. 310 Backstage Burlesque
Fenno Jacobs

Fig. 311 Life,— as advertised
Fenno Jacobs

Famous congressional investigations with important personalities on the stand or among the audience, with their well-known features but looking so vastly different in this atmosphere of tension and suspense than when they face newspaper cameras coming down the gangplank of an Atlantic liner after a pleasant trip abroad. . . Mob scenes, showing strikes, riots, great conflagrations—all such pictures are filled with drama, life and such wealth of emotions, that almost no title is necessary to clarify their meaning. Photographing such great turmoils of humanity requires presence of mind, coolness and complete control of one's emotions as well as one's equipment. That's why such photographs are rare and that is why they are considered priceless.

Human curiosity is boundless. Events that take place in a certain spot excite interest and curiosity throughout the world. Only a few people can see some dramatic or tragic event. But millions would like to see it. The candid camera frequently performs that remarkable service to millions by bringing the event to those far away, who would have liked to be there.

Equipment

It being a prerequisite that your candid camera be portable, unobtrusive and as light as possible, it may not be amiss to suggest equipment which I found most expedient for this type of work.

A Model F Leica with slow shutter speeds is a very important asset. However, those that have older models like D, E, or C, can very easily add this feature without actually converting the camera to a Model F, by acquiring the Slow Timing Device, which is very small, compact and efficient. The slow shutter speeds are important because as long as one has to depend on **available** illumination the difference between ⅛ of a second and 1/20 of a second may mean the difference between having a picture and not having it.

The optics of your camera must be the best. There are three lenses available for this type of work, any one of which will yield excellent results. These lenses are the Summar 50mm f:2, the Hektor 73mm f:1.9, and the Xenon, f:1.5. For those who wish to limit their investment, the Summar 50mm and the Hektor 73mm should be the choice. I use the Hektor 73mm lens for candid camera work indoors, where I want to obtain maximum detail and definition. I also find that this lens gives me a better perspective than any of the other fast lenses. I stop it down to about f:2, which eliminates some of the softness of this particular lens. This is important for purposes pertaining to good composition.

In cases where I want to obtain a view of as large a portion of the stage as possible, or when I want to include a great number of people

Fig. 312 "The world is large and filled with many things..."

Fenno Jacobs

in the picture I use the Summar f:2 lens, which in this instance is being used, in a sense, as a wide angle lens.

Your exposures will range from 1/30 down to ⅛ of a second for the average stage lighting and only in exceptional cases should a ¼ of a second be attempted, unless one can rest the camera securely to avoid movement.

When using the 50mm lenses no other equipment is necessary except a lens shade. When the 73mm lens is used, a suitable view finder will be required to compensate for the smaller field of vision obtainable with that lens. For those who do not wear glasses the Vidom Universal View Finder is probably the best. For those wearing glasses the direct vision view finder (sport finder) will be found more practical.

The Angle View Finder and the Reflecting View Finder will be found helpful in many instances permitting less conspicuous work or work with a camera at waistline level respectively when such may be required.

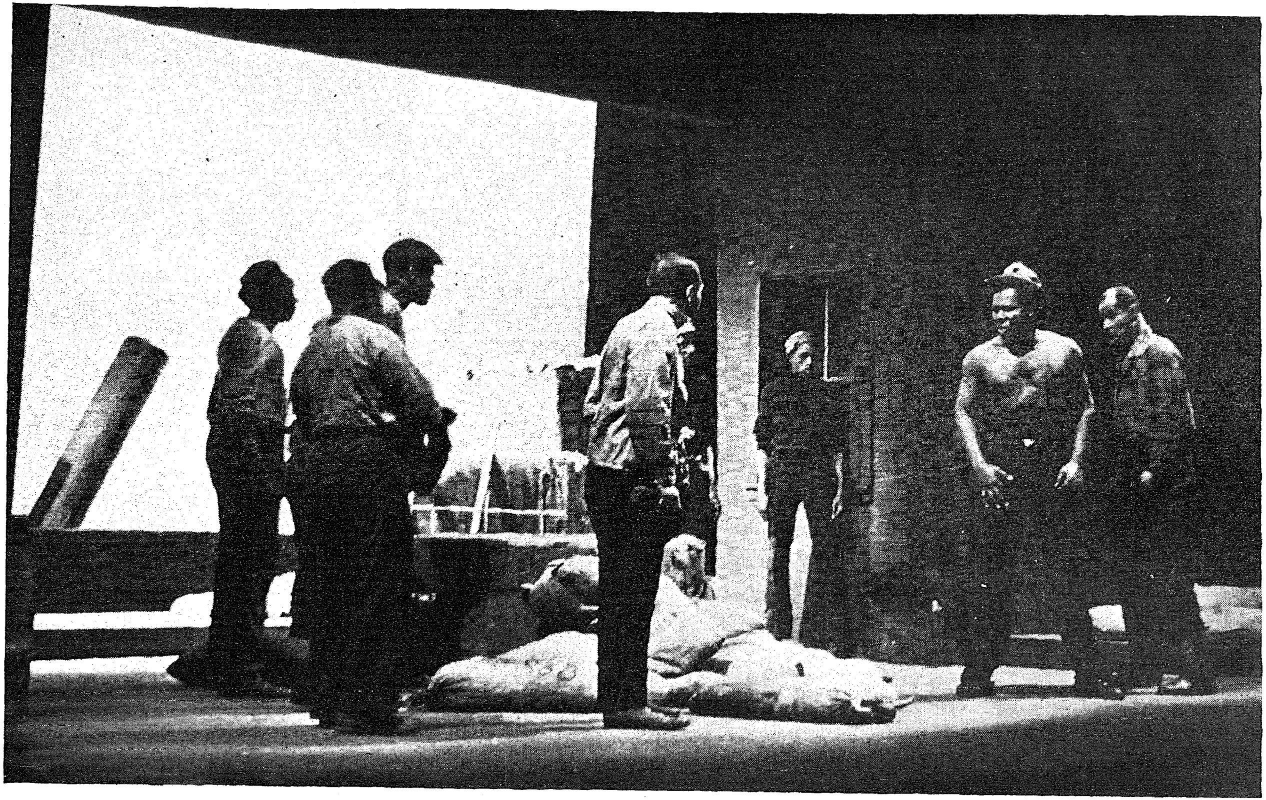
All above accessories are small and can easily be kept in your pockets without making you look or feel weighed down. The only additional requisite will be a good supply of fresh film.

For candid camera work you will do best by using any of the supersensitive panchromatic films which are extremely sensitive to both artificial light and daylight.

The use of a good and dependable exposure meter is very much to be recommended. It is true that for most interior candid camera work you will find little if any opportunity to get a reading with your meter. The work is too fast to permit it, and you will be safe by *giving it all you have got* without fearing over-exposure.

For outdoor candid shots you may use an exposure meter very advantageously and you may use lenses of slower speed.

Whatever you do: when you are out for candid photographs, have as little equipment with you as possible, but never be left without some part of equipment which is essential to get the shot. And, let the slogan "get the picture" be your guide.



Stevedore — Lester-Pickett — Courtesy of The Stage

Summar 50mm lens, 1/8 second at f:2, DuPont Superior fiim

STAGE PHOTOGRAPHY

GLENN H. PICKETT

CHAPTER 25

Photography of actual stage performances is coming more and more into prominence, both in the commercial field and among those theatregoers who delight in recording important bits of action in their favorite plays. The Leica has made this phase of photography very simple and practical. Under the rather broad heading of stage photography may be classed a number of subdivisions such as dramatic productions, musical comedies, operas, movie house stage shows, burlesque shows, dance recitals, and concerts.

It used to be necessary to specially pose the actors, in most cases using far more light than is actually used during performances, in order to procure suitable photographs for publicity. Now it is not only possible, but far more advantageous, to procure actual performance shots which are far superior to posed pictures, with none other than the regular stage lighting. In the commercial field a great percentage of the magazines are now using such photographs. *The Stage, Vanity Fair, Town and Country,* as well as the rotogravure sections of newspapers throughout the country are using actual performance pictures. Thus a Leica user interested in stage productions may very well turn a hobby into a profitable side-line, if not a full-time profession. In fact, there are a number of commercial photographers in New York and other cities who now use the Leica camera in furnishing pictures to magazines and newspapers. The producers and the actors comprise a commercial field in themselves. They are always in the market for good photographs, particularly the actors, and constitute a fertile field for an ambitious Leica worker.

A very recent and fast growing use of the miniature camera in stage photography is that of the producers or directors themselves using the camera to obtain shots of dramatic bits to serve as object lessons for the actors. Shots are taken at rehearsals, prints made and studied by the actors as a means of correcting posture, facial expression, or grouping, before the opening night. Whether it is this branch of stage photography you are interested in, whether you

are a lover of the theatre and require only a picture record for your own files, or whether you desire to commercialize in this phase of photography, the following pointers may prove of special benefit to you.

Lenses For Theatre Photography

The ideal lens for the purpose of theatre photography is the Summar f:2. This lens, due to its wide aperture, its excellent color correction (especially for red rays), its needle-sharp definition at wide open aperture, and the absence of flare, is perhaps the best of all miniature camera lenses for the purpose. However, very good work may be done with the Elmar f:3.5 under favorable lighting conditions, and also with the Hector f:1.9. The latter lens has one advantage in its longer focal length, permitting larger images to be included on the negative from a given distance.

Very few if any accessories are needed for stage photography. In fact, carrying a lot of equipment into a theatre defeats the advantage of the small size of the Leica camera and the ability to procure photographs without attracting a great deal of attention from those around you. One accessory that has been found valuable is the sport view finder. With its use the stage action can be viewed in natural size and the camera kept in shooting position during a long stretch of action. This view finder shows the subject right side up and permits following the action much more easily than with the Universal view finder.

Film and Hypersensitizing

The proper film for such work is, of course, the supersensitive panchromatic type. Any of the various makes are suitable. If higher film speed is required than that of supersensitive panchromatic, hypersensitizing is suggested. An interesting experiment is as follows: in the dark room wind a strip of supersensitive panchromatic film on the reel of either the Correx or Reelo tank and place in the bottom of the tank a piece of blotting paper soaked in the strongest ammonia you can purchase. Place the reel in the tank and cover it, leaving the film in the ammonia vapors for about five minutes. Then take out and load the film immediately into a magazine. Film so treated will show an increase in speed of from two to four times; that is, requiring one-half to one-quarter the exposure necessary for supersensitive panchromatic film. However, such hypersensitized film must be used as soon as possible after treatment and developed as soon as possible after exposure, for it very rapidly loses its speed whether used or not.

Picture Positions In the Theatre

The best position in the theatre from which to take stage photographs depends largely upon the size and layout of the theatre and upon the type of pictures wanted. In musical comedies, revues, etc., where a large part of the illumination is front lighting, it is usually best to sit at one side of the theatre rather than in the center, to prevent a flat lighting effect. The important thing to remember is to sit close enough to the stage so that none of the negative area is wasted. This precludes the necessity of extreme enlargement to bring up the bit of action wanted. Ensemble shots will, of course, require a seat further back than will close-ups of individual actors or small groups of actors.

A broad general rule for photographing musical comedies is to choose a seat further back than that for photographing a dramatic production. In the latter case it is suggested that a seat be obtained just off the aisle, in the first, second or third row. If the photography is for commercial purposes, especially for publicity, arrangements can sometimes be made with the manager of the theatre to choose the best vantage point in advance, and in some cases permission may be obtained to move around the side aisles during a performance. Another good arrangement is to occupy a box seat on the first balcony level, this giving an unobstructed view of almost the entire stage and better values of light and shade than would a seat directly in front of the stage.

Fig. 314 The Milky Way Lester-Pickett
Summar 50mm lens, 1/30 second at f:2.2, DuPont Superior Film

In photographing dance recitals or ballet dance groups, of course, it is important to look down on the stage to at least a slight degree rather than to shoot from below, and consequently this means choosing a seat either in the balcony or a box. This is to avoid cutting off the feet of the performers in the picture.

Judging Exposures

The greatest problem for an inexperienced stage photographer is judging the light intensities, and information on this point is best gained by practice. Exposure meters are practically worthless in this work as they give only an average reading of the light and dark areas and include too wide an angle, so that if any reading can be had at all, nine times out of ten any exposure made according to that reading would be considerably overexposed. Most stage lighting is contrasty, and while the average meter reading would be very low, the brilliantly lighted parts of the stage action would read very high if that part alone were measured.

It has been found that the ratio of the most poorly lighted scenes to that of the most brilliantly lighted is about one to fifty, actual shots taken in New York City theatres varying from about one-quarter to one two-hundredth of a second with a lens aperture of f:2. Because of the frequent use of shutter speeds in the order of 1/20, 1/8, 1/4, etc., the Leica Model F camera with its automatic slow shutter to one second is much more valuable for this work than the older models. However, with practice, the shutter speeds slower than 1/20 can be guessed fairly accurately when using the shutter set on "bulb". Learning to judge the proper exposure is not very difficult, requiring but little experience because of the wide latitude of present-day film emulsions.

It has been found in New York City theatres that the most brilliantly lighted stage productions are the large movie-house stage shows, some of them being so brilliant that 1/200 of a second at f:2 was not short enough to prevent overexposure of spot-lighted faces. Next in order of brilliancy come the musical comedies (especially during the performance of featured stars in spot light), dance recitals, the opera; and probably the least brilliantly lighted are the straight dramatic productions in which usually there is but very little more light than will be found in the average lighting of the home. Of course there are exceptions in each of these cases. As a general rule, the size of the theatre governs to some extent the amount of light used on the stage. The larger the house, the brighter the lighting. This is so that those farthest from the stage may have less difficulty in observing facial expression.

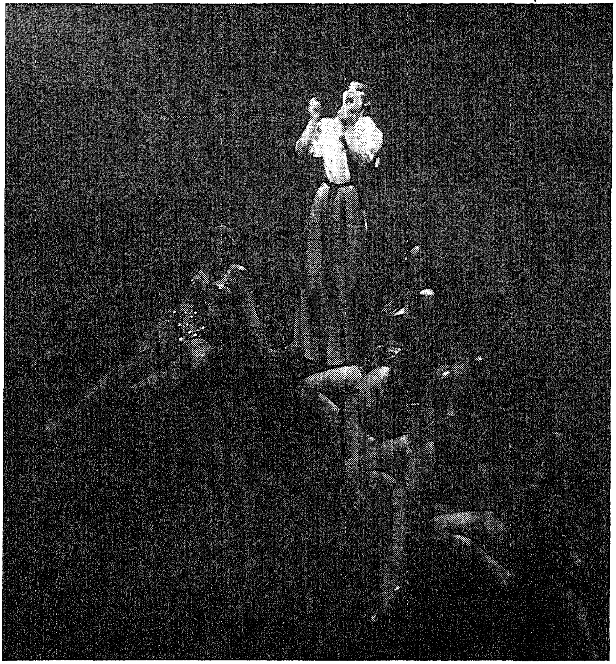


Fig. 315 Frances Langford and Albertina Rasche Girls in a scene from "The Pure in Heart"
Lester-Pickett
Summar 50mm lens, 1/8 second at f: 2, DuPont Superior film

After shooting one or two rolls of film, a pretty fair idea of the varying light conditions will be formed. It has been found to be a good plan, when using the Summar lens, to leave its aperture wide open. This leaves only the shutter speed to adjust during the variations in light conditions, it being easier to adjust in the darkness of a theatre than the aperture ring. If it is desired to feature in the picture the highly spot-lighted stars at the expense of the other players or objects on the stage not so brilliantly lighted, by all means use a rather fast shutter speed. This prevents over-exposure of faces under the brilliant lights—a very common fault in artificial light photography. However, in ensemble numbers in a musical comedy, for instance, if it is desired to preserve detail in the less brilliantly lighted portions, give plenty of exposure and take care of the over-exposed negatives in development, about which more will be said later.

A good procedure in focusing is to *keep the camera focused on the principals of the play.* If the background or other members of the cast are

slightly out of focus this will merely enhance rather than lower the pictorial value of the picture. However, at the average shooting distance of thirty feet, the actual depth of focus at f:2 will be from 22 to 40 feet which will take care of the average depth of the stage, and sometimes even its width (when shooting from the side or from a box).

Technique of Slow Exposures

It may be thought that at the slower shutter speeds considerable movement will be evidenced in the finished picture. While true to a certain extent, this can be prevented by carefully watching for slight pauses in the action. There are usually times when the pose is held momentarily and even shutter speeds of 1/8 or 1/4 of a second can be used with a minimum of blurring in the picture. It is this fact which makes performance photographs of a stage production far more valuable than the posed pictures taken in the customary manner and under favorable light conditions. Fortunately those scenes in which the greatest amount of action takes place are usually the more brilliantly lighted, and fast shutter speed can be used. When shooting at the slower shutter speeds (that is from 1/20 to 1/4 of a second) there will be little chance of moving the camera if the elbows are placed on the arm rests.

Experience has taught that plenty of film should be used. Despite the best of luck and a good deal of experience, important

Fig. 316 Roxyettes Rudolf H. Hoffmann
Hektor 73mm lens, 1/60 second at f:2.2, DuPont Superior film

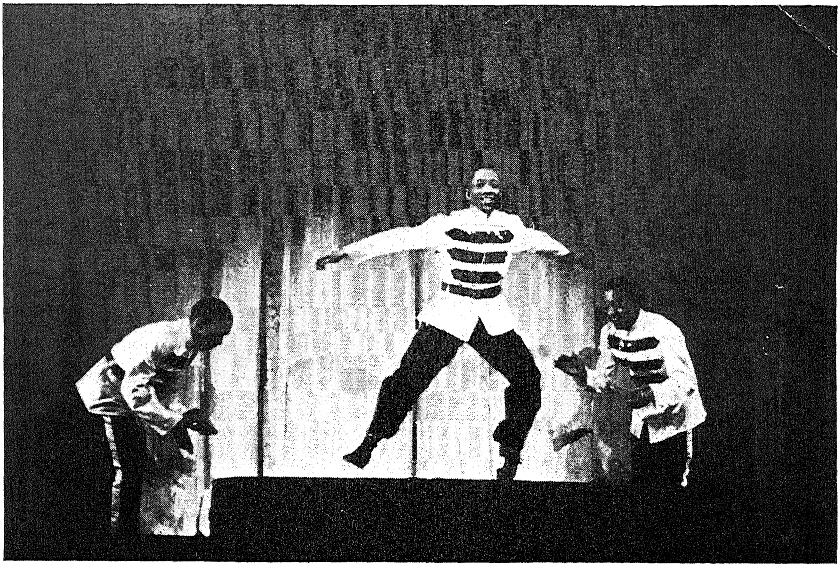


Fig. 317 Black and White Henry M. Lester
Summar 50mm lens, 1/60 second at f:2.2, E. K. Super-X film

scenes will pass so quickly that the most desirable shots will be missed. Therefore a good plan is to take at least three loaded film magazines to the theatre and when a dramatic episode occurs, take a great many shots thereby raising the percentage of good pictures. Aim to use one roll of film for each act. For instance, in a three-act play, change the magazines during intermissions. If, however, you are able to attend the show once without taking pictures, to establish in your mind those scenes which you wish to preserve and then attend with the camera and one roll of film, you are enabled to choose the important parts and be prepared for them when they occur.

Developing the Theatre Negative

Now as to proper manipulation of the film after the exposures are made. The present day tendency in development is to work for as fine a grain as possible regardless of what such developers do to the film speed—which is considerable. Fineness of grain and high film speed are generally not compatible. The very popular Paraphenylene Diamine actually reduces the film speed to about one-half its rating when developed with a normal developer. This shows up particularly in the shadow portions of the picture which are usually very important in a stage shot, inasmuch as they are very poorly lighted in the majority of cases. If these shadow details are

lost, fineness of grain is of no consequence due to lack of detail in the finished picture. By choosing a position close enough to the stage and thus minimizing the extent to which the picture must be enlarged, the grain problem does not enter seriously into consideration. Therefore, it is suggested that a good, normal developer be used, such as the Eastman D-76 or its later development, the Buffered D-76; Dr. Sease No. 3 Formula, in which the film speed is upheld by the use of Glycine along with the Paraphenylene Diamine; or the double development method, first with metol then with Paraphenylene Diamine. These are all normal developers and uphold the film speed very well. The reader is referred to another portion of this book for the above formulas.

Overdevelopment is particularly to be avoided because in the attempt to maintain shadow detail, very frequently it is necessary to use a slower shutter speed, thus overexposing the highlights. Both from this standpoint and from that of fineness of grain, it has been found that a tendency to underdevelop or shorten the normal development time results in better pictures. This is especially so if a developer in which metol is a constituent is used, as this chemical flashes up the shadow detail very quickly and it is with prolonged development that overexposed highlights are blocked up.

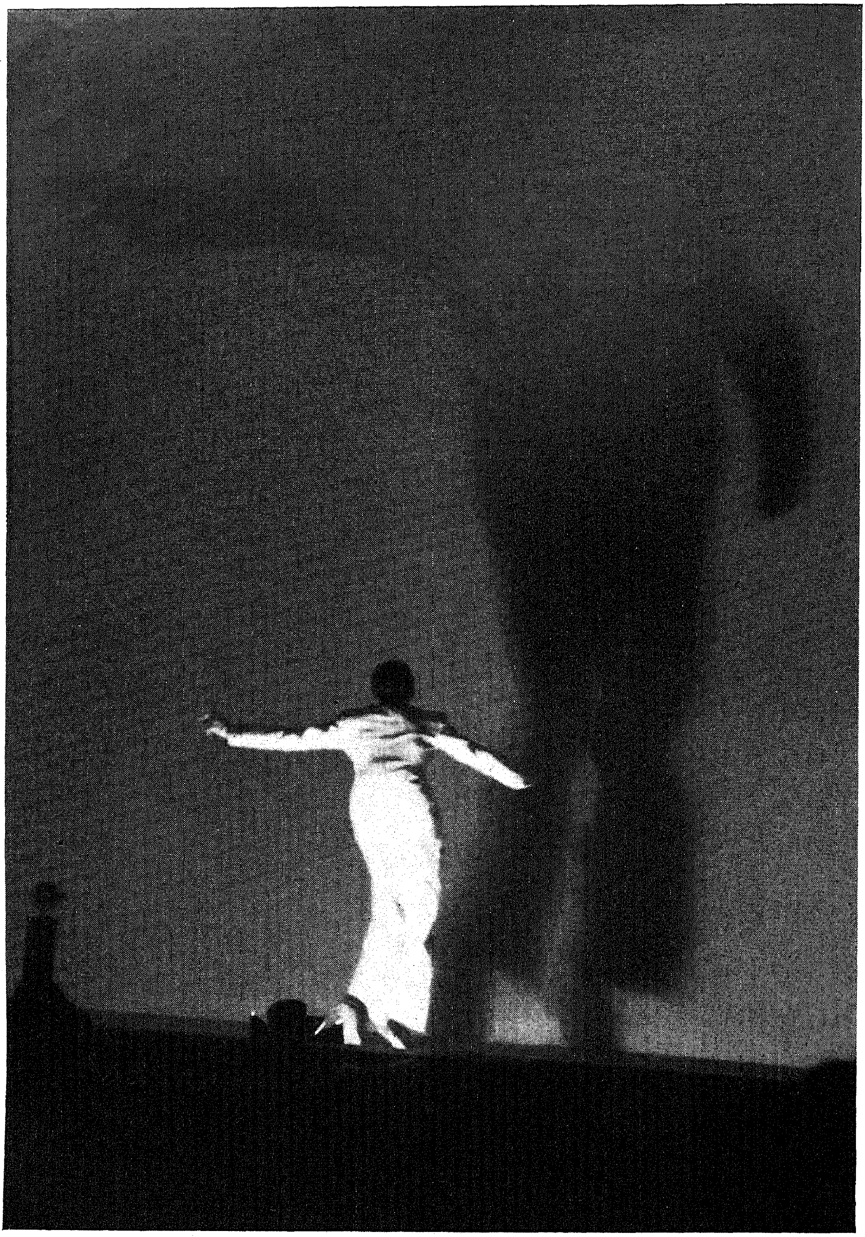
Careful handling of the film throughout the entire process cannot be too strongly emphasized. The negatives obtained in stage photography, especially if they are to be used commercially, are sometimes required to produce a great many paper prints and scratched and dirty negatives are of course to be avoided. It is suggested that a special hardening bath be used between development and fixing. This not only reduces the danger of scratching the film but also helps to prevent reticulation. More information on this phase can be found in the chapter on development.

Human Interest Photos

While you are at the theatre there are scores of interesting shots other than those upon the stage. For instance, the dressing rooms of the stars, if permission to enter them can be obtained, offer many excellent candid shots that are very much in demand by modern magazines. Snapshots (unposed) of noted persons attending the theatre, taken in the lobby either before the show or during intermission, are very interesting and sometimes salable. Carry your camera with you to the lobby during intermissions and watch for prominent people or interesting groups gathered there for a cigarette and a breath of air. There are always good shots at this time. Take a few views also of the exterior of the theatre with its display of brilliant lights and patrons alighting from their limousines. All of these shots add materially to the value of your photographic story of the show whether for your own use or for publication.

In the writer's opinion, no other branch of photography is more interesting than actual performance photography of stage productions, and it is highly recommended to those Leica users who are looking for new thrills and accomplishments with this versatile camera. Whether you are located in metropolitan areas where there is a wealth of musical and dramatic productions to choose from or whether you reside in the smaller localities with only an occasional stage show at the local movie house, a better chance to experience genuine pleasure in the field of photography could hardly present itself.

Fig. 318 Ethel Waters Rudolf H. Hoffmann



Shadow Dance — Gilbert Morgan

Hektor 73mm lens, 1/40 second at f:1.9, Agfa Superpan film

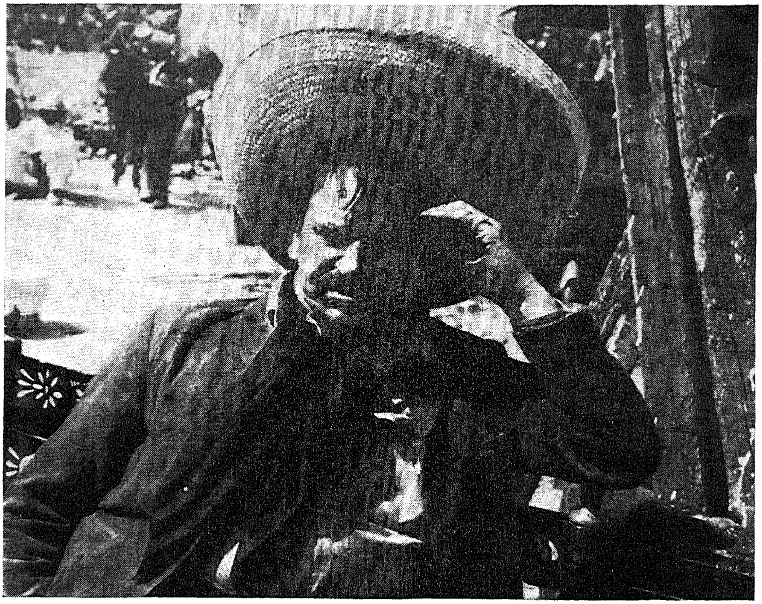


Fig. 320 Wallace Beery in Viva Villa James Wong Howe

THE LEICA CAMERA IN THE HOLLYWOOD STUDIOS

GILBERT MORGAN **CHAPTER 26**

During the past few years the changes in the motion picture industry have been rapid and radical. Over night silent pictures began talking and black and white movies burst into colors. Motion picture photo-montage was continually being perfected. Among these dramatic changes appeared the Leica camera which found immediate acceptance by the camera men and directors. Here was a miniature camera which could make record pictures, film and filter tests, also replace the heavy and cumbersome still cameras in many instances at a great saving in time and money. In this brief chapter I can only give a general survey of the various applications of the Leica in the motion picture industry.

The camera department of a studio saves much time and money by testing new film emulsions and new types of film with the Leica

instead of with the motion picture cameras. By using the Leica with a lens similar to that of the motion picture camera, and with the same set of filters, a true test can easily be made on a five foot strip of film which with a motion picture camera might well have been a hundred or two hundred feet long. The advantages of the Leica over the motion picture camera in such tests are unquestionably due to

Fig. 321 Dancers — Victor Haveman
Summar 50mm lens, 1/200 second at f:2.2, DuPont Superior film

the compactness and adaptability of the small camera together with the saving in operating costs. With the motion picture camera, film testing is a longer and more involved process. There are the inconveniences of setting up the large camera for film and light tests when a small camera will do the same work on a short roll of film which shows the consecutive test exposures. With the motion picture camera the separate shots will be about ten feet apart.

Location Scouting

For the cameramen who have been out making location shots, in the mountains, at the beach or in the tropics, naturally the light and color conditions are different than they would be in more

Fig. 322 Joe E. Brown, Warner Bros. star, poses for a Leica Picture by Frank McHugh, while James Cagney and Otis Harlan look on. All wearing costumes used in "A Midsummer Night's Dream"—picture directed by Max Reinhardt. Photo submitted by Carl Schaefer.

familiar surroundings. Since the developing laboratories are apt to be from two days to six months away, the results are always doubtful until the negatives have been developed and reported upon. Because this condition exists, many of the cameramen have made it a practice to take their Leicas and Correx or Reelo developing tanks with them wherever they go. They are thus able to complete their exposure tests with their Leicas and be certain of the results in a period of about twenty minutes. In this way, many thousands of feet of film are saved, and it is not necessary to travel back to the same locations for retakes, due to exposure and filter difficulties.

James Wong Howe used the Leica extensively testing for angle and perspective shots as well as filter shots while in Mexico City filming *Viva Villa.* Through the use of the Leica he was able to study the characteristics of the country and of the people and to incorporate some of his findings in the motion picture. After seeing his Leica negatives, one wished that more of the picturesque exterior shots, so typical of Mexico, had been included in *Viva Villa.*

Arabia was the scene of Felix Schoedsacks' recent location trip. While there he made many reference pictures along with the filming of backgrounds for an R. K. O. picture which deals with the Arabian desert and the camel caravans. Approximately 5000 Arabs and 3000 camels were used. Since part of the picture was taken from an airplane, the small size of the Leica for use in taking still pictures was hardly to be considered extra baggage after the motion picture

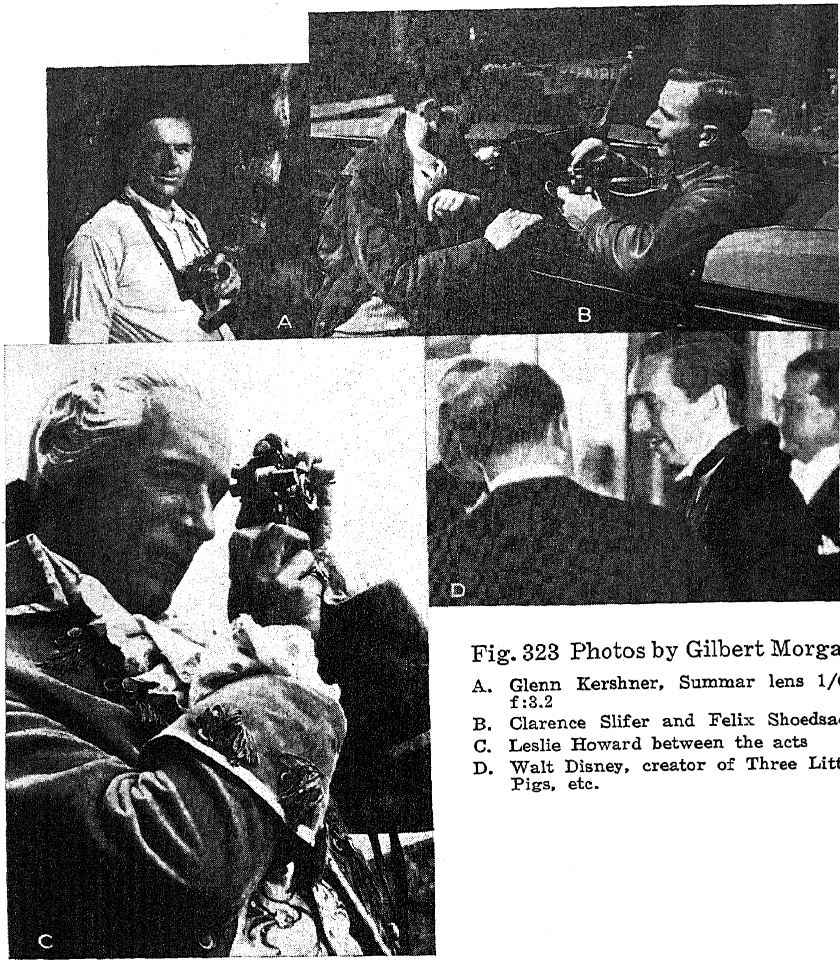


Fig. 323 Photos by Gilbert Morgan

A. Glenn Kershner, Summar lens 1/60 f:3.2
B. Clarence Slifer and Felix Shoedsack
C. Leslie Howard between the acts
D. Walt Disney, creator of Three Little Pigs, etc.

camera and accessories had been loaded into the plane. A number of these Leica pictures were reproduced along with an article in *Travel Magazine.*

The Leica has been on motion picture expeditions with such cameramen as Guy Wilkie in India, Glen Kershner on his trip to Labrador with MacMillan, as well as in Tahiti with Universal Pictures, Paul Ivano with Josef von Sternberg in the West Indies, Alvin Wyckoff with the Seven Seas Co., in the Hawaiian Islands, Karl Straus with Paramount in Honolulu and with many other first cameramen who are traveling places and photographing pictures for the screen.

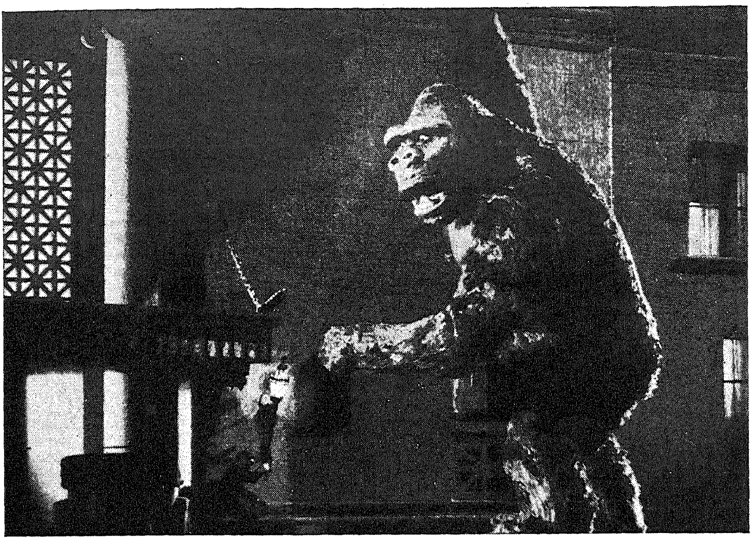


Fig. 324 King Kong Gilbert Morgan
Illustrating the use of a miniature set in Hollywood Studios

When the Leica made its first appearance in Hollywood, Jackson Rose introduced it to the studio location departments as a means of making it possible to have more photos of the prospective locations that were to be decided upon. Furthermore, by the making of film strip positives and viewing the still pictures on a screen, a director and his staff can soon make a definite decision for filming the script before them.

Technical Reference Photos

Many times a man is sent out with a Leica to take various technical photos of a steel mill, a powder factory, construction company, types of houses in the various foreign countries, boats, natives or anything in the world that might be called for in a motion picture. These photos are brought back to Hollywood and are used for reference work in designing costumes, building the Chinese junks or reconstructing parts of the factories and steel mills. Many and more detailed photographs first taken by the Leica aid in obtaining more realistic surroundings in motion pictures.

In the process and trick department many of the stills that are impossible to take with the large cameras are made with the Leica because of the similarity of the focal length of its lens with that of the motion picture camera. The miniature sets of cities, buildings and airplanes are made to appear real on the screen on the 35mm

film. If they had been photographed on an 8 x 10 plate, they would look so distorted that the public would probably say "fake" from the start. We don't mind being fooled providing the technical work is carried on well and is unobserved by the eye.

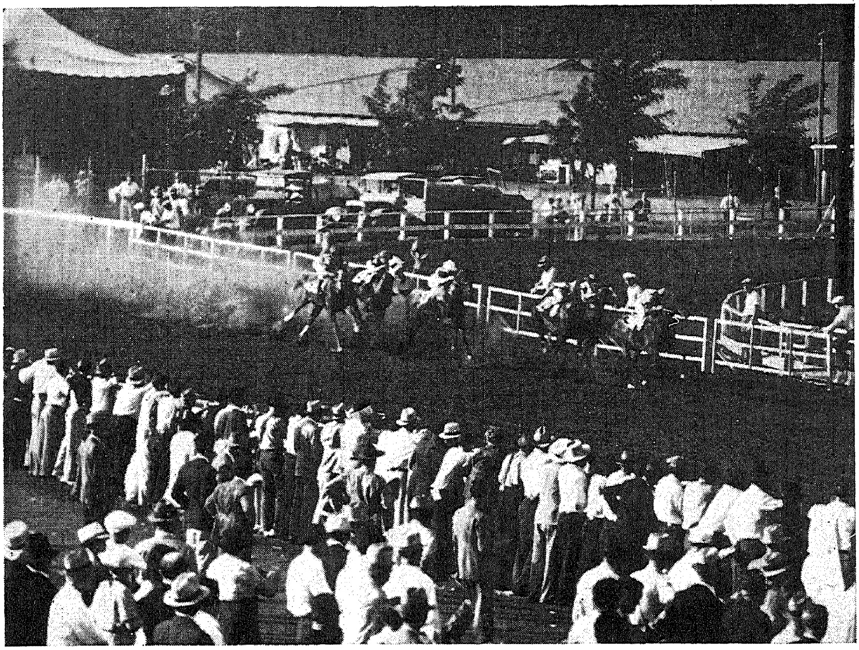
At present, tests are being carried on to enlarge the Leica negative on a $3\frac{1}{4}$ x 4 lantern slide plate in order to project the plate up to approximately eighteen feet on a transparent screen. This is projected from the rear while the actors and actresses do their parts in front of the screen and the motion picture camera records the action together with the Leica scene that is projected on the screen. When the composite is viewed on the movie screen it may look as though you were seeing your favorite film star in darkest Africa engaged in breath-taking experiences, when in reality he is safe on one of the trick department's sound stages doing his stuff.

Make-up and Candid Photos

To show just what can be expected on the screen, the make-up departments use the camera to test the different types of face powders under the incandescent as well as in daylight. With trick make-up it is very necessary to be able to tell beforehand how the different colors will register on the film.

During the past few years, the candid variety of still pictures have been very much in demand by the leading magazines and newspapers of the country. The result of this demand has caused the publicity departments of the studios to look about and have more of this type of photo made by the still men. The Leica has been chosen for this type of work because of the ease in obtaining the picture under all the different conditions which may arise. Exterior action

Fig. 325 At De Long's Make-Up Studio
Gilbert Morgan

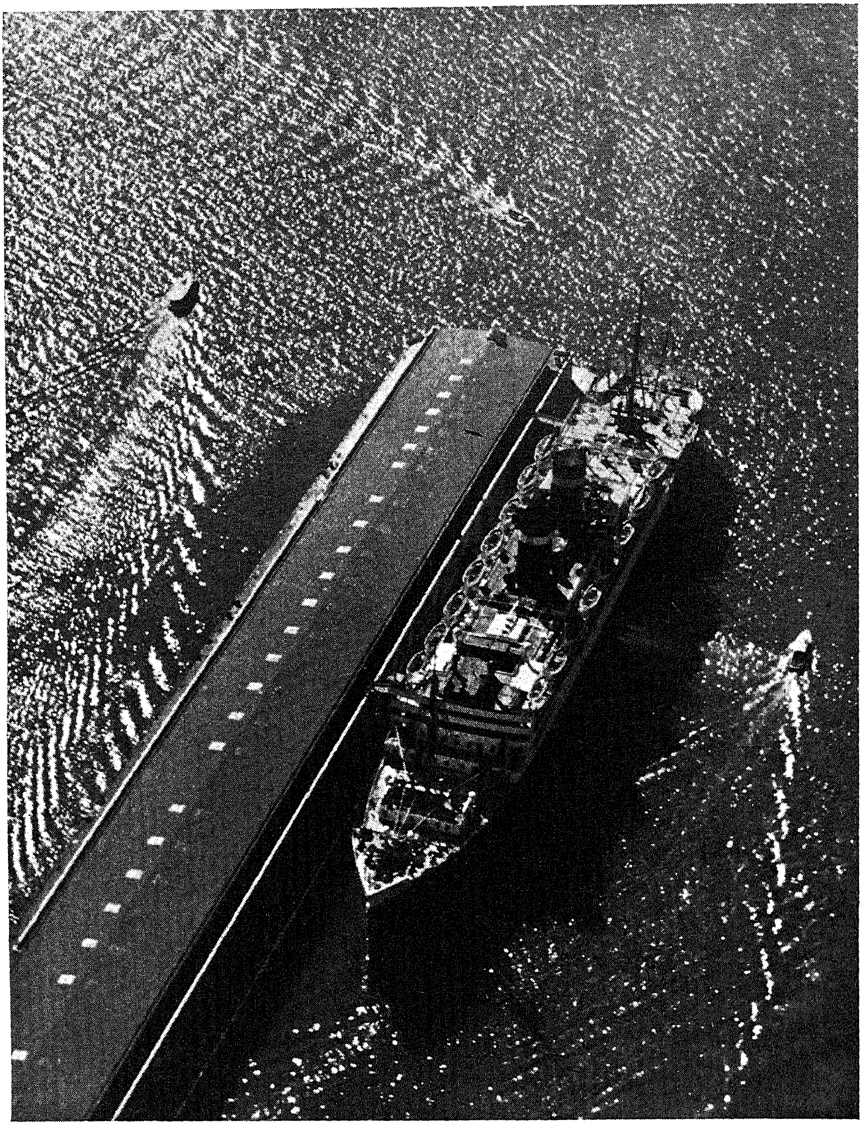


Racing in California — Gilbert Morgan
Telyt 200mm lens, f:4.5, 1/500, Agfa Superpan Film.

photos are taken with the Leica with excellent results. Many of the candid photos taken of John Barrymore and Carole Lombard during the filming of one of their recent pictures were used by the *Vanity Fair Magazine* in their candid sketches of the picture people.

The motion picture fans are tiring of the same old posed photos of their favorite actor or actress, and now they want to see them as they really are, caught in the act of laughing, talking, eating, dancing or walking. In other words, they want to see their actors real, life-like and above all, natural and human.

Finally the actors and actresses of stage and screen are using the Leica for pleasure as well as for obtaining pictures for their own professional use. After all every user of the Leica should really give credit to the motion picture industry and the motion picture film manufacturers for the marvelous technical work they have done in perfecting the film we use in our cameras today. We now have available slow and fast films for every photographic purpose, a selection in the 35mm film size which is greater than that of any other camera. The future will bring many new innovations in faster films, fine grain emulsions, as well as improved color films.



Sunlit Water

John P. Gaty

Altitude 1600 feet, Elmar 90mm lens, 1/200 second at f:4, No. 2 Leitz Filter, DuPont Special Panchromatic Film

AERIAL PHOTOGRAPHY

JOHN P. GATY

CHAPTER 27

Aerial photography is one of the most fascinating of all the many and varied branches of the art. It permits the capture of scenes of grandeur and beauty observed only by the airman, and their preservation to the end that they may delight his friends and acquaintances. Whether or not those who view the result are airminded, it will be found that aerial photographs possess interest for almost everyone. To the timid, they offer a glimpse of the aerial world denied them by their timidity. Others will look upon them with longing and recall memories of similar scenes witnessed for some brief moment in the past; or will project their imaginations forward to the day when they also will leave the earth below and take to the aerial heights.

This universal interest is heightened if the photographer selects his subjects with an eye to the dramatic and impressive effects that are recurrently produced by the forces of the atmosphere. With Nature's moods constantly changing, and with the vast expanses of far flung vistas of land, sea, mountains, and sky as his subject matter, it would be a dull photographer indeed who did not respond with his best efforts. The resulting print may carry the menace and threat of the towering black and silver ramparts of a thunderstorm as it sweeps down on the diminutive homes of a city, or it may render the light and gay mood of a cloud feathered summer sky above a peaceful countryside. The opportunities for expression exist in abundant measure.

The aerial photographer soon discovers an interesting peculiarity about his work, in that his photographs always show more details than his eye can grasp at the moment of exposure. He thus finds out many interesting facts about apparently familiar territory. On cross country trips by air, a series of photographs will record more than the unaided memory. Before the human eye can possibly scan an entire vista for small details and compare the relationship of all objects to each other, the airplane has moved on to an entirely new location. But the camera possesses the ability

to record everything within its field of coverage instantly and preserve it for leisured study. Even local areas reveal surprising facts to those who are apparently perfectly familiar with them, when photographed from the air.

The Leica camera possesses an important advantage for aerial use in that a single turn of the winding knob sets the shutter and simultaneously changes the film. This feature is very desirable; especially when a quick series of exposures must be made while flying over an objective. All professional and military aerial cameras of the highest class are equipped with similar winding arrangements for hand operation, even when their principal function is that of fully automatic electric operation.

Aerial Compared to Ground Photography

Successful and interesting air views demand a somewhat different technique from that required for ground pictorial photography. Less opportunity is presented for study of the subject and careful selection of a camera location with reference to the objects to be photographed. The ground photographer can select his viewpoint and putter around while weighing the balance of his composition in the finder or ground glass, and after several changes and

Fig. 329 A Summer Storm over the Catskills John P. Gaty
Altitude 1200 feet, Elmar 50mm lens, 1/200 second at f:4, No. 2 Leitz Filter, DuPont Special Panchromatic film

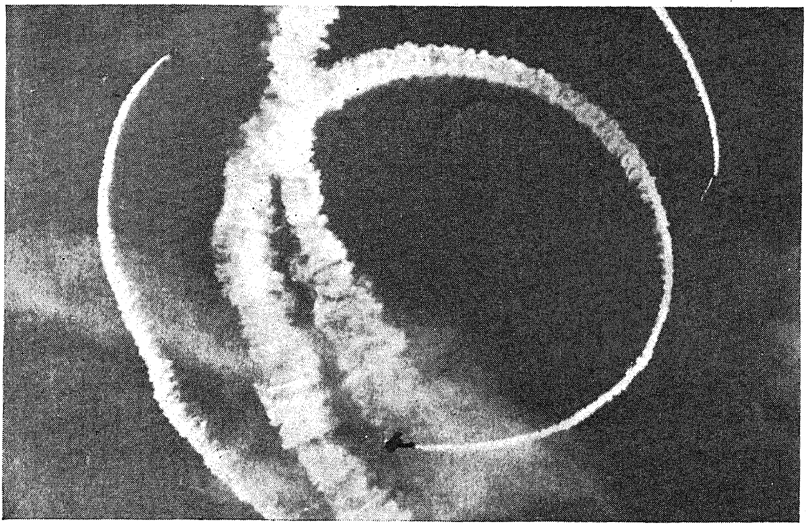


Fig. 330 Sky Writers Clarence Slifer
Elmar 90mm lens, 1/500 second at f:4.5, DuPont Superior film

prolonged cogitation decide not to take the picture at all! The aerial photographer actually must anticipate his composition and expose it at the split second that it is best. There is no time for prolonged decisions. At a speed of one hundred miles or more per hour, the opportunity is almost fantastically short.

Another advantage possessed by the ground photographer is the presence of foreground objects of appropriate nature to aid in balancing the composition. The aerial photographer usually is deprived of these, because the only near objects ordinarily are the parts comprising the structure of his own airplane. It is most unusual to find such things an aid to composition, for they are seldom in sharp focus and almost always angular and intrusive into the frame line. Even if they happened to add to the composition pattern, there is the unfavorable factor of great separation of image planes between the structural objects and the nearest objects on the grounds. There is no possibility of gradually leading the observer's eye into the distance by a succession of gradually removed planes, hence his reaction to the abrupt mental jump from near object to the ground is unpleasant. This effect is decreased if the airplane is flying at low altitudes or just over a cloudbank. Every rule has its exceptions and in certain cases some advantage may be gained from including part of the airplane

in the view. For the ordinary picture the photographer must form his composition from patterns on the ground and in the sky, using large masses for the high altitude views; and buildings, fields, roads, rivers, or what not for the low altitude views.

Leica As a Profitable Aerial Camera

Those who wish to put their aerial photography on a self-supporting or profitable basis must remember that quality is the touchstone of success in this field. While there is a certain limited market for conventional stereotyped airviews, lacking composition and originality, the sales effort necessary in the disposal of this type of product is at least disheartening. Those photographers who possess imagination and good judgment will find a ready market for their air views, providing that the technical details of developing and enlarging are given the same careful consideration as their camera work.

Scientific, topographic, and mapping aerial photography are highly specialized arts which require long training and intricate cameras and apparatus. The only type of aerial photography to be considered here is "oblique photography". In aerial parlance, an "oblique" photograph is one made by a camera pointing to-

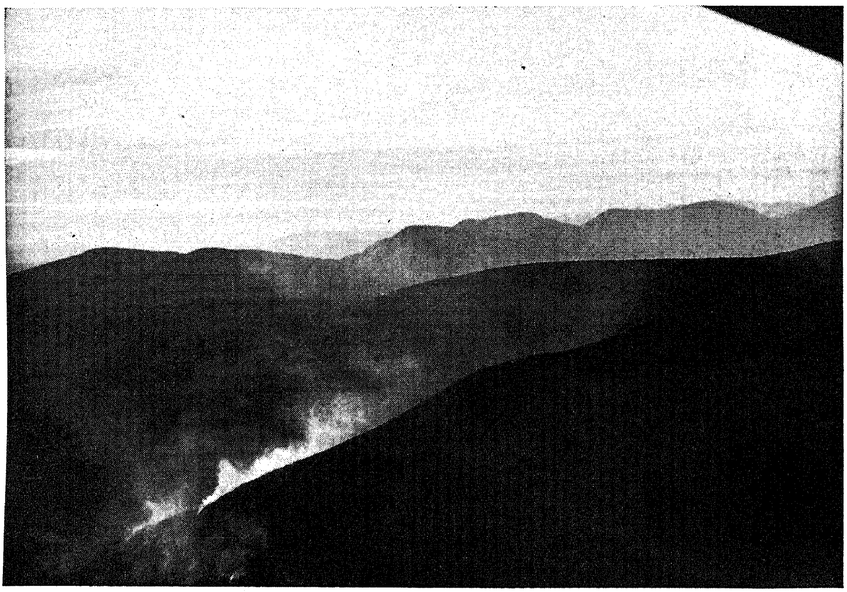


Fig. 331 Fire on the Ridges John P. Gaty
Altitude 5500 feet, Elmar 50mm lens, 1/200 second at f:4, No. 2 Leitz Filter, DuPont Special Panchromatic film. In this case aerial haze proved desirable; its presence helped to produce the separation of perspective between the ridges

wards the ground, at some angle substantially less than a right angle to the horizontal plane. Photographs made in this manner are often termed "air views". They satisfy the greatest part of the market demand available to the independent aerial photographer. Their viewpoint is readily understood by the layman, while that of the vertical photograph is often confusing to the uninitiated.

The best market for air views is to be found among owners of estates, farms, and homes. These properties usually constitute one of the most important interests in the lives of the owners. An aerial photograph showing in an attractive manner the carefully planned details of an estate is a very desirable and tempting thing to the owner. It represents a new means of explaining to others his methods and plans for developing the estate, and actually is the sole method by which the entire property can be visualized at once. The same considerations apply to the farmer, except that his interest has more of a business nature and his planning is more utilitarian than esthetic. Both classes share the feeling of pride of possession and accomplishment. For this reason they are particularly receptive to approach by the aerial photographer.

Contacts with home owners lead naturally to industrial aerial photographic opportunities. By carefully building up his clientele, the enterprising photographer will receive offers of contracts to photograph factories, colleges or institutions, resorts, real estate developments, and other subjects. Local newspaper editors should be shown sample photographs of scenes of interest in the neighborhood. If striking or unusual treatment is evident it is likely that a sale will be made. The editor should be advised that future work will be submitted for his inspection.

Starting Your Own Aerial Photo Business

When starting in business, the aerial photographer first should make a ground survey of likely subjects. Careful study must be given to each to determine the favorable photographic angles and the type of lighting that will be most helpful. As the position of the sun changes in the sky the lighting will change from side to side or from back to front, and the angle of lighting will vary. After noting all pertinent photographic facts the photographer should find out something about the owner, for future reference. Out of these first subjects, he should select a few in the same vicinity and take his Leica into the air and photograph them, at the time of day previously selected. Several trips should be made, if necessary, to get the proper lighting. The next step is to develop

the films and carefully make enlargements of the good frames. These enlargements constitute the samples that are to be shown to prospects and no effort should be spared to make them perfect. If some of the negatives are blurred it is best to reject them and try again. A group should be made up for each owner and submitted to him for inspection. A fair price should be set on the prints and cheerfully maintained in the face of smaller offers. The owner realizes that the photographer has no other market for these samples and naturally attempts to secure them at a low figure. However, enough sales ordinarily will be made at the selected price to cover the initial costs incurred in setting up a book of samples.

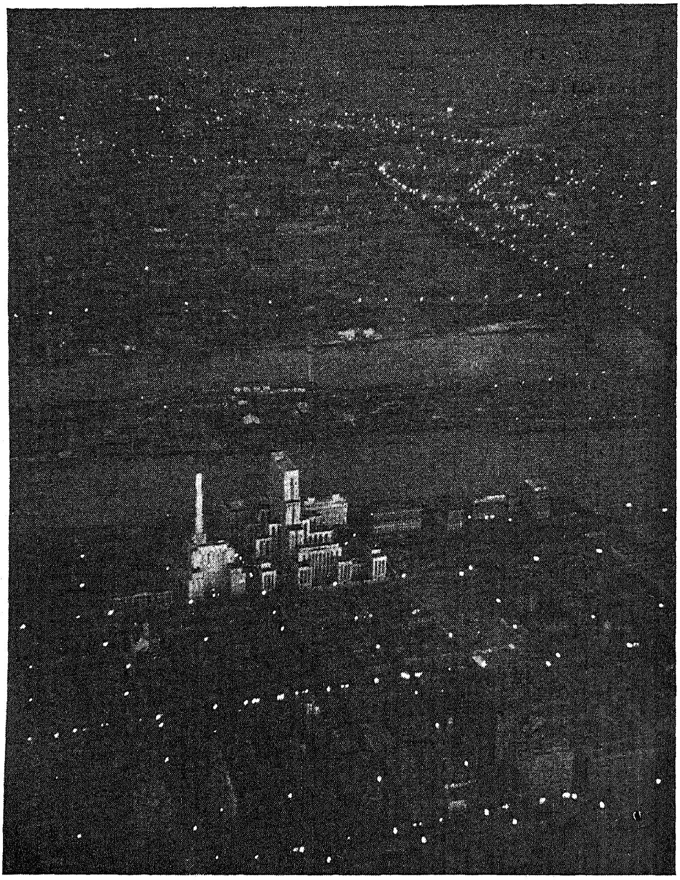


Fig. 332 Nightfall John P. Gaty

Taken 40 minutes after sunset, midsummer. Altitude 2000 feet, Summar 50mm lens, 1/20 second at f:2.3, DuPont Superior film

Further sales should be made on a contingency basis. The owners of properties selected as subjects should be approached and shown the book of samples depicting the properties of their neighbors. Unique or interesting features of the property of the "prospect" should be discussed and commented upon with regard to their appearance from the air. The photographer should offer to make air views of the property for an agreed price, to be paid only if the owner is satisfied after inspection of the finished prints. If he is not fully pleased with the results it is fully understood that he owes the photographer nothing, incurs no future obligation, and obtains no pictures. The photographer rarely loses a sale made on this basis, as the owner is filled with anticipation for the air views and usually has made up his mind to pay for them at the agreed price. Each photographer must determine for himself what his costs are and how high he can profitably set his prices. A price schedule in the lower-middle range would be as follows:

Local photographs (*one customer*)	
2 different air views...............	$20.00
4 " " "	$30.00
6 " " "	$35.00
Reprints of any air view...........	$ 2.50 each.

These prices are based on economical flying costs and short distances from the base to the objectives. The costs of long flights should be added to the usual prices set up to cover local customers. Once established, the price structure must be rigidly maintained to all customers in the same vicinity.

Customers should be followed up occasionally, as they may have shown their air views to friends who wish similar work done, or they may wish air views made of seasonal crops or vegetation. Sometimes they require new views with a change of season. A satisfied customer is always acting as a salesman for the photographer, and may often produce considerable business of an unexpected nature.

Many Leica owners may wish to make aerial photographs to present to their friends as gifts during the holiday season. Such air views are a source of pleasure to both the photographer and the recipient. General aerial scenes of a striking nature are prized by almost everyone, and views showing the homes of the photographer's friends are greatly appreciated by the owners. Enlargements intended for this purpose should be finished with the same degree of care accorded to those which are intended for sale. It is usually best to mount them attractively or to print them with wide borders.

Making the Preliminary Ground Survey

In order to obtain the finest aerial pictures of homes, estates, or buildings, a ground survey should be made prior to the day chosen for the photographic hop. The subject should be studied for the most promising photographic angles and their relation to the light direction at various times of the day. If the building has an industrial significance its function and usefulness should be studied, together with its placement with regard to related subjects. For instance, a resort hotel ordinarily would be near numerous places of recreation such as golf courses, beaches, mountains, or other places for guests to amuse themselves. A factory would be near transportation facilities, such as railroads, harbors, or rivers. The photographer should ask himself the question, "What is the purpose of this place and how can it be shown to best advantage in an aerial photograph?" The background objects should be observed carefully, as some may be objectionable and some desirable. The air view will disclose them, and camera angles may have to be selected that will include only the desirable features. The problem sometimes becomes complicated if favor-

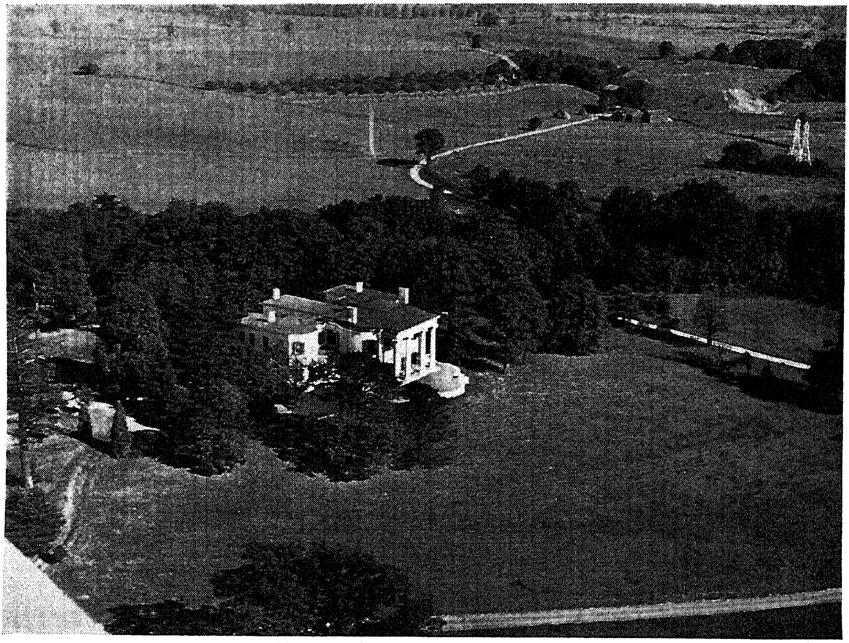


Fig. 333 A Country Estate John P. Gaty

Altitude 500 feet. Elmar 90mm lens, 1/200 second at f:4, No. 2 Leitz Filter, DuPont Special Panchromatic film

able lighting, purpose, and background are in mutual conflict. A compromise must be made in such cases, and the intelligence and ingenuity of the photographer are given a thorough test.

Background objects are important in the photography of homes and estates, in the same manner. Transmission lines, railroads, cheap developments, and other industrial manifestations have a habit of cropping up in the distance when the aerial photographer is studying the camera angles of a sumptuous estate sequestered from the world by a private forest. Unfortunately, sometimes, the camera "sees" over the top of the sheltering trees and registers objects which the owner would dislike including in a picture of his home. Conversely, there may be a rugged mountain near, or a pretty lake, and these would be desirable objects to show in the photograph of the estate.

Controlling Perspective by Lens Selection

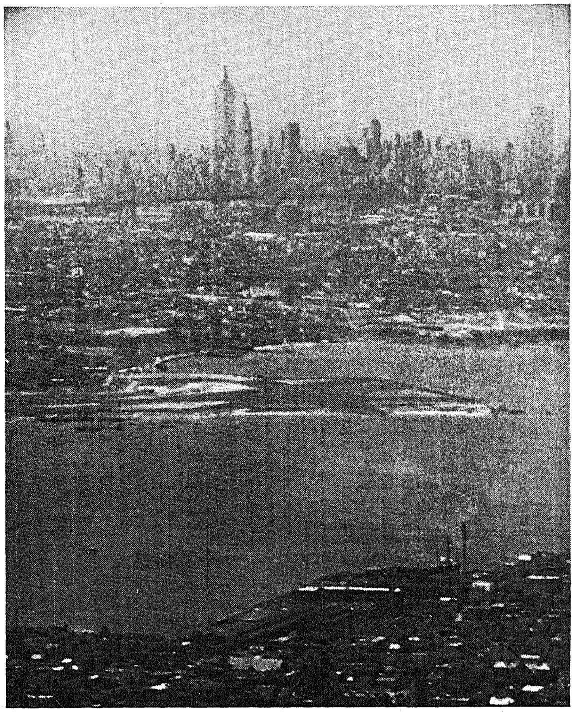
Fortunately for the photographer faced with these problems of what to show and what not to show, what to emphasize and what to subdue, the Leica is equipped with a full battery of lenses. Ranging from the 35 mm. lens with its wide field of 69 degrees to the 135 mm. lens with its narrow field of 18 degrees, they provide a flexible instrument in the hands of the capable photographer. By properly selecting an appropriate lens and the *proper position* with regard to the principal object of interest, great liberties may be taken with the apparent perspective in the finished enlargement. Background objects or foreground objects may be moved into apparently near or distant positions at the pleasure of the photographer. Such effects are not magical. They depend on simple laws of perspective. When a near viewpoint is adopted and a wide angle lens utilized, the resulting photograph will show a rapidly vanishing perspective and the background objects will be subordinated. If a distant viewpoint is selected and the same principal object of interest photographed with a long focus lens the photograph will show a slowly vanishing perspective and the background objects will be apparently much nearer to the principal object. Relative distances of various objects in a photograph can be judged only by their apparent relative sizes.

The real secret of the change in perspective lies in the position of the camera with respect to the various objects depicted, and not in the lenses. A choice of lenses is necessary in order to preserve the sharpness of the distant views. The long focus lenses produce larger images and fill the frame with the view desired. This may be enlarged to the desired size without running into the difficulties from negative graininess sure to be experienced when a small portion of the

center of the frame is selected as the basis of a sizeable enlargement. Aerial photography demands clean cut definition of the highest order, and attempts by the photographer to secure this in large prints made from small portions of the negatives are doomed to failure. This high type of definition is essential because almost all details are exceedingly small and the eye of the observer seeks natural and well known shapes, such as the windows of houses in the distance. If these are not reasonably sharp the reaction is unfavorable and the enlargement is condemned as being blurred.

If a photographer attempted to make a 35mm Elmar lens do the work of a 135mm Elmar or Hektor lens he would have to take the same position and altitude for either lens and would find that the 35mm lens had imaged the selected view on but 1/16 part of the area of the normal frame. The remainder of the picture would be composed of sky and objects in which he had no interest. If he attempted to enlarge the small area showing the desired view he would start under a 4 to 1 handicap against sharpness as compared to that obtainable with the 135mm lens in a similar size print. On the other hand, it obviously would be impossible to use a long focus lens for a purpose requiring a short focus lens, for the angular coverage would be insufficient to include the desired objects, at the selected

Fig. 334 North Beach Airport, New York City — John P. Gaty
Wide Angle View, 1/3 mile to Airport; 6 2/3 miles to distant Manhattan buildings. Altitude 1000 feet, Elmar 35mm lens, 1/200 second at f:4, No. 3 Leitz Filter, DuPont Superior film.



North Beach Airport, New York City

John P. Gaty

Telephoto View. Camera—7 miles from Airport and 13 1/3 miles from Empire State Building. City smoke prevented better contrast and definition. Altitude 2000 feet. Special 200mm Experimental Lens, 1/60 second at f:6.3, No. 3 Leitz Filter, DuPont Superior film

distance from the principal object of interest. The presence of aerial haze in the atmosphere might absolutely prevent increasing the distance to a point where the long focus lens would cover the desired view, even if the convergence of the perspective were unimportant. Many times, when aerial haze is dense, close-up photographs can be made successfully under conditions that would prohibit making "long shots". *In all cases a proper lens hood should be used with each lens*, whether the air is clear or otherwise, and whether the view is far or near.

The two lenses that are most useful for aerial use with the Leica are the 50mm Elmar and the 90mm Elmar. With these two as a nucleus the beginner can work to earn money that will enable him to purchase further equipment. In order of their usefulness, other lenses would be the 35mm Elmar, the 135mm Elmar or Hektor, the 50mm Summar, and the 73mm Hektor. The first two are useful because of their widely differing angles of coverage, and the correspondingly large degree of control that they permit the photographer to exercise over the apparent perspective shown in his prints. The latter two lenses are useful because of their large apertures,

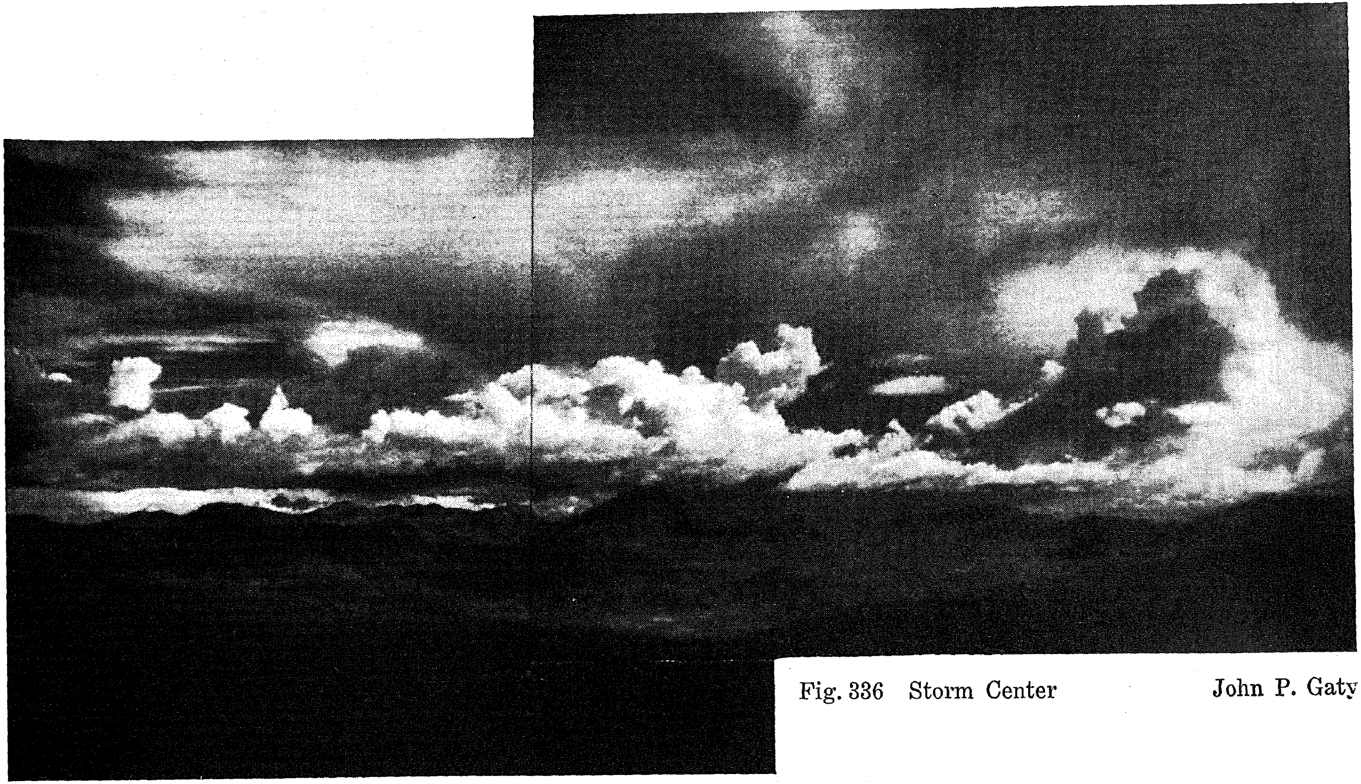


Fig. 336 Storm Center John P. Gaty

A composite View of a winter snowstorm over the California Coastal Range. Note the upper air flow proceeding forward and outward from the center. Altitude 2000 feet. Summar 50mm lens, 1/100 second at f:2.3, No. 25 Wratten Filter, DuPont Infra-D film, hypersensitized

which permit aerial photographs to be taken under unfavorable light conditions. These maximum apertures must be used with discretion, since overexposures may be produced under ordinary lighting conditions. Their use is not recommended except for unusual lighting and for certain combinations of slow films and dense filters.

The use of the various lenses will depend on just what result is desired in the print. If subordination of background seems advisable the short focus lenses such as the 35mm and 50mm Elmars should be used, in connection with a relatively close position to the principal object at the moment of exposure. Similarly, these lenses will increase the apparent size of a given area of land, due to the rapidly converging perspective. Long focus lenses such as the 90mm Elmar or the 135mm Elmar or Hektor will produce the effect of bringing mutually distant objects to an apparent relative juxtaposition, if the position of the camera at the moment of exposure is correctly distant from the principal object of interest.

Filters for Aerial Photography

Light filters are almost universally used in aerial photography, because the distances commonly intervening between the majority of

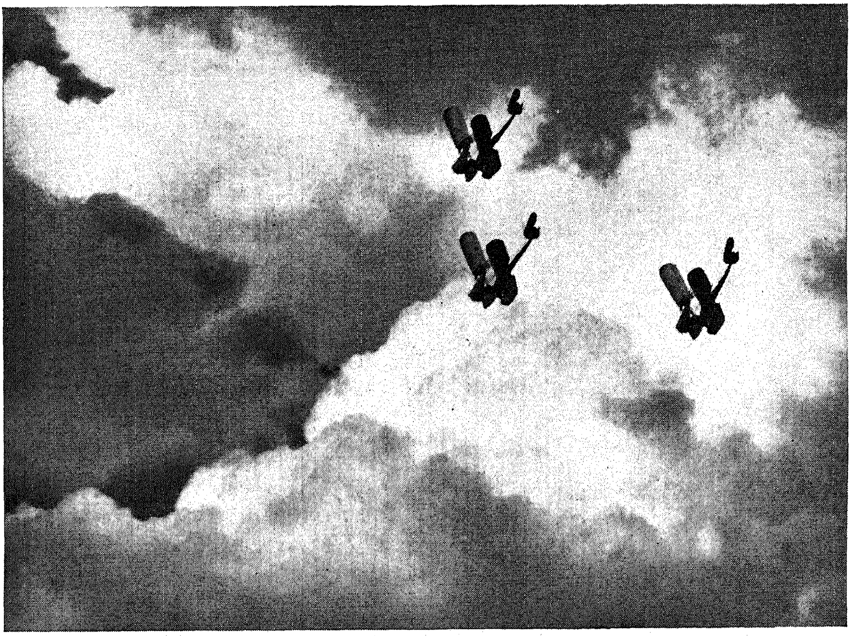


Fig. 337 Diving — John L. Davenport

Composite Photograph. One airplane photograph repeated three times upon a cloud photograph

the objects in the view and the camera are great enough to cause dispersion of the shorter wave lengths of light by the aerial haze. This dispersion results in a general veiling of the details of distant objects and the production of "flat" negatives lacking brilliance and contrast. Yellow or red filters are used to eliminate the action of the shorter wave lengths of light on the film and thus remove the veiling effect of the aerial haze. Leica filters numbers 1, 2, and 3, remove varying percentages of the shorter wave lengths of light, the restriction increasing with an increase in the number. Sometimes a portion of the shorter wave lengths is desirable for the purpose of aiding the longer wave lengths in making a correct exposure under unfavorable light conditions. In certain cases aerial haze is advantageous in the extreme background. Such examples require the use of a number 1 filter. For the great majority of cases Leica filter number 2 will be the correct one to use, and this filter is recommended as the first choice. Leica filter number 3 allows slightly better penetration of aerial haze and sometimes will be found useful. A red filter similar to the Wratten 25 (light red) may solve some problems beyond the scope of the yellow filters, and is useful also for infra red photography.

Filters for Different Visibilities

In order to give a readily understandable general rule for the use of filters the following table shows the correct filter for use for different visibilities expressed in miles. The table is intended for use with supersensitive type panchromatic film only.

Visibility	*Filter for Close-ups (up to 2000 feet)*	*Filter for long shots (intermediate and long distance)*
Unlimited	no filter	No. 1 or No. 2
10 miles	No. 1	No. 2 or No. 3
5 miles	No. 2 or No. 3	No. 3 or Red (No. 4)
3 miles	No. 3 or Red (No. 4)	Red, (useful to 1 mi.)

The proper use of filters often becomes a compromise between unfavorable light conditions, permissible exposure time, and atmospheric haze. The table shows the least dense filters which may be used under the tabulated conditions. In any case a more dense filter may be used if the light conditions or air conditions permit the slower exposures necessary. Slower exposures are permissible in smooth air than are practical when the air conditions are turbulent. The use of longer exposures than 1/200 second in turbulent and bumpy air usually results in blurred pictures, especially when long focus lenses are used.

When conditions are favorable and the air is free from atmospheric haze, the minimum density filter should be used in order to

increase the shutter speed. This is especially true in cases where a cloudless sky shows in the background. The use of a dense filter will render a clear horizon as a rather depressing shade of gray in the print. This may have to be dodged out in the enlargement. The proper use of filters, therefore, is influenced by the condition of the sky if any of it shows in the composition. A further factor is the direction of lighting. Haze is much more apparent when looking or photographing against the direction from which the light falls. In photographs taken against the light, add one to each number of the filters recommended in the table, and consider the red filter as number 4.

A Standard Leica Aerial Exposure

Exposure speeds will depend on a great number of factors. In order to avoid confusion, **the standard Leica exposure for aerial photography should be 1/200 second, with a diaphragm aperture of f:4, and a number 2 filter, when the camera is loaded with supersensitive type panchromatic film.** Ninety percent of all aerial photographs can be made safely with these factors, because film latitude will compensate for the minor variations experienced in lighting.

Superpanchromatic type film is used exclusively in professional aerial photography. Long experience has shown it to be far superior to any other type of film. Its sensitivity to the longer wave lengths of light permits its use in conjunction with all types of filters that are helpful in aerial photography without the necessity of greatly increasing the length of the exposures. Modern superpanchromatic emulsions are fine grained and capable of rendering excellent definition. In order to realize their full potentialities, the photographer must take every precaution during the developing, fixing, washing, and drying of the negatives. Ample information on the processes of fine grain developing is available elsewhere in this volume. The rules laid down must be carefully observed at every step. Aerial photography with small negatives will never be successful if the photographer is slipshod and careless in his darkroom technique. The requirements of fine detail in the enlargements cannot be satisfied with grainy negatives.

Certain panchromatic films possess inherently finer grain than the superpanchromatic type, but their use involves the employment of slower shutter speeds. Such films are DuPont Micropan, and Eastman Panatomic. They are suitable mainly for aerial photography from cabin type airplanes, because the longer exposures required often produce blurred negatives if the camera is subjected to

the eddies of the propeller slipstream. The factors for these films with various filters will be found in other parts of this volume. Such factors should be applied to the standard conditions outlined above in connection with supersensitive type panchromatic film. Diaphragm changes can be made to compensate for decreased film sensitivity, in cases where high aperture lenses are used. This practice is not recommended, since the "fast" lenses were not designed for this type of work and are subjected to an unfair test by the exceedingly high requirements for detail. The extreme apertures of the "fast" lenses should be reserved for emergency use in overcoming otherwise unconquerable light conditions.

Infra Red Photography

Infra red sensitive film, such as DuPont Infra D, provides an interesting experimental medium. Very unusual photographs of

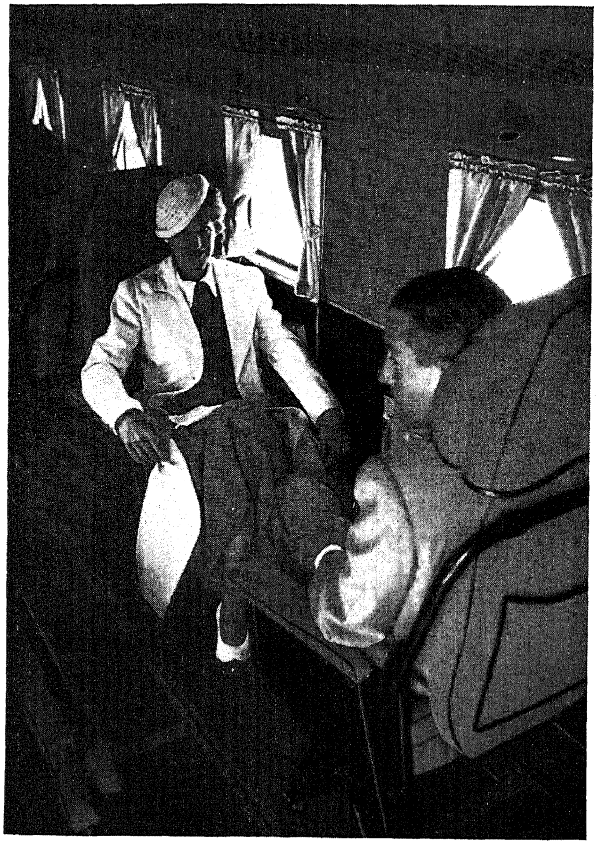


Fig. 338 Interior of Transport Air Liner
John P. Gaty

Air travellers may photograph their fellow voyagers if they wish. Elmar 35mm lens, 1/20 second at f:3.5, DuPont Superior film Aboard Douglas TWA Transport

clouds and atmospheric effects can be secured with this material, and great penetration of atmospheric haze can be obtained by its use. Certain difficulties must be overcome by the photographer in order to secure presentable aerial views from these infra red sensitive materials. The filter must transmit only red light, and the exposure must not be shorter than 1/20 second at a lens aperture of f:3.5. This long exposure usually is productive of vibratory blur in the negatives, and great care is necessary to prevent camera movement during exposure. When the air is rough and turbulent the photographer's task is almost hopeless. The infra red films are apparently readily subject to large grain formation in development, and every safeguard must be adopted in the darkroom to produce fine grained negatives. When using this material the Elmar series of lenses should be set to 100 feet on the focusing scale, the Hektor series to approximately 200 feet, while the Summar lens has a special focusing mark for infra red film. These adjustments are necessary to correct for the difference between the panchromatic and infra red focus of the lenses.

Infra red sensitive material offers a very interesting field for unusual photographic effects, but before its full potentialities can be realized the photographer must give considerable study to the effects produced in the prints. He is unable to visualize the response of the film to various light conditions, and the reflection coefficients of various natural objects and surfaces to infra red light in any other way. One especially interesting experiment is to use infra red film in connection with filters passing the higher ultra violet spectrum and the infra red spectrum together, but cutting out all of the visible spectrum to which the film is sensitive. Wratten gelatines can be used for this purpose, and the combination of Quinoline Yellow No. 17, and Rose Bengal No. 30 will do the trick. If less ultra violet is desired a No. 49 or No. 49a may be added to the first two, although these cut out the shorter infra red rays also. The use of No. 17 and No. 35 is also recommended. The exposure with the first and last combinations should be 1/20 to 1/30 at f:3.5, and that of the combinations with the No. 49 filters, 1/20 at f:2.0.

This deliberate selection of the extreme opposite ends of the spectrum implies that the photographer has great faith in the color corrections of his lens, and undoubtedly would cause a lens designer to have a severe headache if he could know about it. The 35mm Elmar will work satisfactorily under this unfair handicap, which is

a great tribute to its design and construction. The print reproduced herewith (Fig. 339) was made with this lens and a No. 17 and No. 35 Wratten filter used together. It shows a very unusual

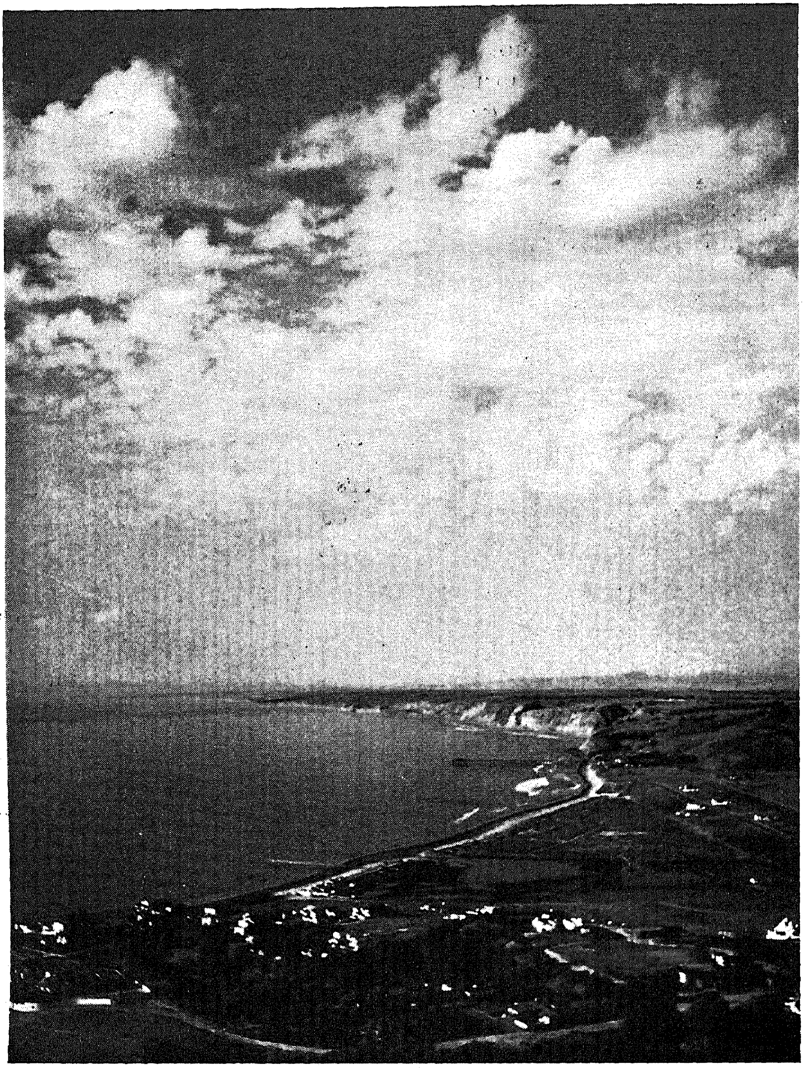


Fig. 339 Coastline John P. Gaty

This photograph was made by invisible light only: ultra-violet and infra-red. Note the absence of the usual infra-red effect of white foliage. Compare this with that shown in Fig. 340, which was taken with infra-red light only. The distance in this picture is limited to the foothills shown in Fig. 340.
Altitude 1000 feet, Elmar 35mm lens, 1/100 second at f:3.5, Wratten Filters No. 17 and No. 35 used together, DuPont Infra-D Film, hypersensitized

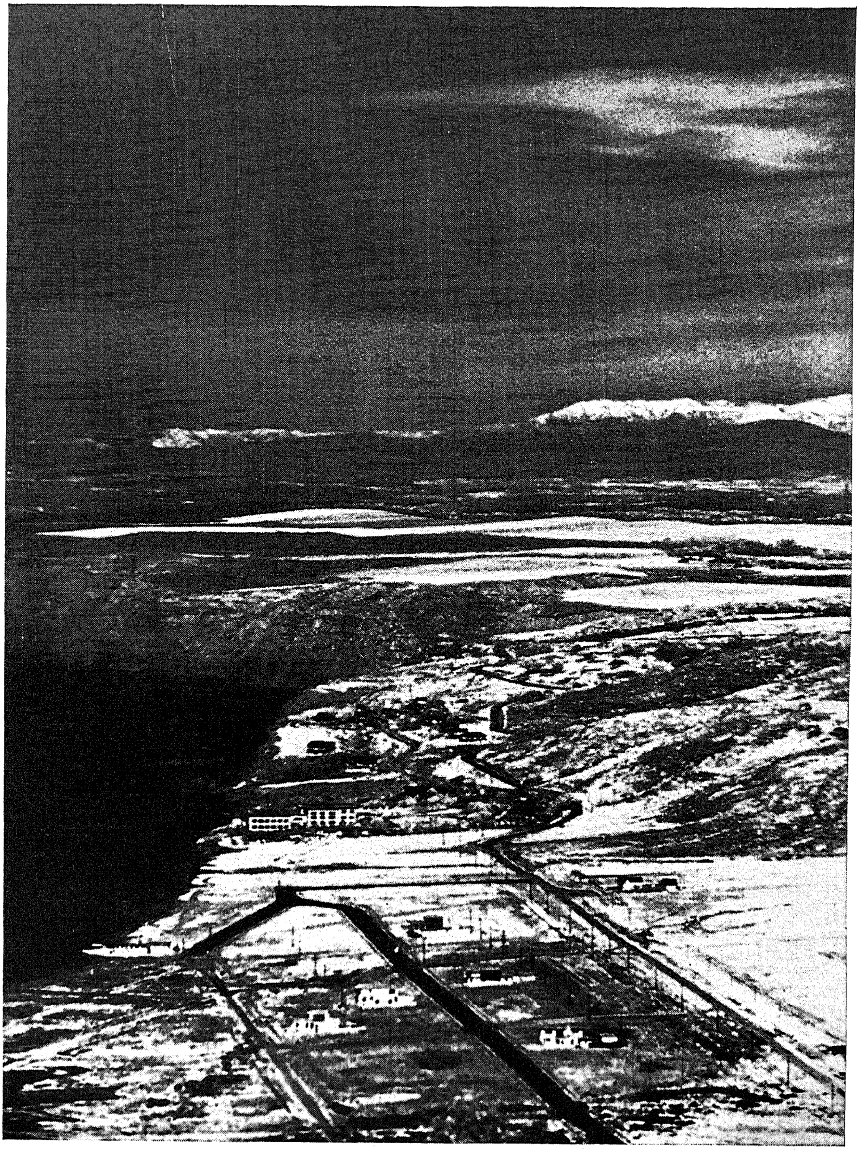


Fig. 340 Distance John P. Gaty

This photograph includes part of the view shown in Fig. 339. The long focus lens brought out the reasonable size of the snowcapped mountains. The large mountain is 70 miles away, while the smaller mountain is more than 100 miles distant.

Altitude 1000 feet, Elmar 135mm lens, 1/30 second at f:4.5, Wratten Filter No. 88A, DuPont Infra-D film, hypersensitized

balance of atmospheric effects. Near the horizon the sky tone shades off to the palest possible gray, yet the clouds are rendered in bold relief near the zenith. A panchromatic film would show the horizon as a much darker gray if a sufficiently dense filter were used to correct the upper sky to a comparable tone. It is also evident that the usual brilliant and unnatural rendering of green foliage by infra red light is completely absent.

Use of Orthochromatic Film

Orthochromatic film of certain types, such as Perutz, possesses excellent inherently fine grain. This film should be used in aerial photography only for close-up shots on clear days. The use of any sort of yellow filter slows the speed down considerably and has a tendency to destroy the definition. This destruction of definition is not due to poor filter surfaces but to a peculiarity of the orthochromatic emulsion. The blue and red portions of the visible spectrum are capable of rendering excellent definition but the intermediate portion, including the green and yellow, shows only approximately half the resolving power. Orthochromatic films when used with yellow filters are forced to work with this unsatisfactory portion of the spectrum and therefore produce inferior definition. When this effect is added to the slow shutter speed conditions it is natural that orthochromatic film should produce disappointing results in aerial photography with the Leica.

Preventing Vibration During Exposure

The most important part of the technique of handling a Leica in the air is the avoidance of camera movement during exposure. Such movement may be derived from three sources: 1. Motor vibration is transmitted to all parts of the structure of the airplane, and if the camera is allowed to touch or rest upon any part of the fuselage vibratory blur will show in the negatives. 2. The slipstream from the propeller is filled with gusty vortices and these transmit intermittent energy to the camera when it is exposed to the blast. 3. The third source of movement is derived from the motion of the airplane itself. Smooth motion along its path rarely affects the sharpness of the negatives except at very low altitudes, and even under these conditions compensation may be obtained by swinging the camera with the principal object of interest as the airplane passes by it. This motion should be a slow gradual swing controlled by maintaining the object fixed in its chosen location in the field of the viewfinder. It should continue before and after the exposure. The great source of difficulty from motion

results from turbulent and bumpy air. The airplane rocks and bucks and sometimes it is impossible to keep the object located in the viewfinder for more than a second. If the photographer can register a view between bumps, all is well. If not, he will find a series of blurred negatives as the result of a photographic hop. When the wind is high and the air bumpy, it is better to postpone aerial photography. Certain air conditions make an airplane no more suitable for photography than would be the rear seat of a roller coaster car in full career. In any case the greatest effort should be made at all times to protect the camera from all sorts of motion during exposure, by cushioning it with the hands, and protecting it from the slipstream of the propeller, as well as by attempting to anticipate whatever bumps may be encountered.

An Eveready carrying case or the use of a special neck strap for the Leica provides insurance against its accidental loss over the side of the airplane. Even when several different lenses are carried and a larger case is used the Eveready case will be found convenient. An ample supply of extra film spools should be carried with the different types of film intended for use during the flight. The ends of the leaders should be marked in pencil with the name of the film so that no mistake will be made when the camera is hurriedly reloaded. In this connection, of course, the new 250 exposure Leica will hardly require reloading during a flight. Sometimes when the film suddenly comes to an end, just as the airplane is circling over its objective, the large Leica is ardently desired.

Photographing From Transport Air Liners

Aerial photography from transport air liners offers some unique problems. The windows are made of shatterproof glass that is far from optically flat, and usually are incapable of being opened. The irregular surface of the glass has a tendency to "soften" the image on the film, and the interior surface reflects light from the windows on the opposite side of the cabin. In order to overcome these handicaps the photographer should select a short focus lens and hold the camera as close to the window as possible, without actually touching the glass with the lens mount. This practice will reduce the abberations due to the uneven glass and to some extent shield out the interior reflections. By placing the body close behind the camera or by holding up a coat, the remainder of the reflections may be eliminated. Usually the rear and front seats are the best locations for photography from air liners, since the view is least obstructed at these points.

Your Personal Airplane

In selecting a personal airplane for aerial photography the various open photographic angles should be considered carefully. High wing cabin monoplanes are usually the best for all around use. They

have the greatest number of camera angles, the photographer and camera are fully sheltered from the slipstream of the propeller, and they are comfortable in cold weather. However, any airplane may be used if it possesses sufficient open spaces between the structural parts to permit an unobstructed field for the shortest focus lens to be employed. When such spaces are barely sufficient, more care must be used by the pilot in manoeuvering the airplane into the proper position to take a desired view, since in effect the airplane, and not the camera, must carefully be lined up with the object. Some airplanes have open spaces only at the two rear quarters between the lower wing and the tail surfaces. Such "ships" must be flown past the object before the exposure can be made. The photographer is in much the same case as the Woople Bird who always flew backwards because he wasn't interested in where he was going, but only in where he had been.

The photographer must possess a ready means of communication with the pilot at all times. In double cockpit open airplanes Gosport voice tubes and helmets may be used, or a system of hand signals arranged. Such signals must be worked out carefully before the flight so that there is no possibility of confusion. The photographer's wish for a change in altitude, direction, or position must be understood instantly by the pilot. Cabin type airplanes usually are so arranged that the photographer can converse readily with the pilot at all times. In cases where the pilot is also the photographer some "ships" will prove very unsatisfactory while others are fairly convenient. In any case it will be found that serious aerial photography is performed in a better manner when two individuals co-operate to do it.

Airplanes may be tested for their camera angles on the ground by the use of the Universal finder. This should be used to check the open photographic angles from the seats or spaces available for the photographer. Horizontal angles alone must not be considered. The viewfinder axis should be depressed downward to 45 degrees or more, and raised upward slightly in order to check all possibilities. At the same time the change in attitude of the airplane after the tail is raised in flight should be considered.

Aerial Photos At Low Altitudes

When using a personal airplane, the enthusiastic photographer often will be tempted to fly at extremely low altitudes to secure some detailed views of his objective. Unless these are isolated farm houses surrounded by fields suitable for forced landings, such practices must

be considered hazardous. If the pilot attempts low altitude flying over populated areas, some aggrieved citizen is almost certain to report him to the Department of Commerce, with resulting trouble for the pilot. If the photographs are important and require low flying, a written application should be made to the local Department of Commerce Inspector, specifying the location, the date of the proposed trip, and other details. A waiver of the rules will be issued at the discretion of the Inspector, and subsequent trouble avoided.

Aerial photography is surprisingly easy to accomplish, but in order to obtain full satisfaction the photographer must be uncompromising in his attitude of watchfulness and care.

1. The camera must be held properly.
2. The film and filter correct for the conditions and subject.
3. The developing handled in the most precise manner.
4. The enlarging done on paper adapted to the contrast values of the film.
5. The proper lens should be employed, at the correct distance, to fill the frame with the desired view.
6. Last, but by no means least important, showmanship should be used in preparing the prints. They should be mounted, or printed on paper large enough to provide a wide border around the exposed area. Careful spotting and retouching of blemishes must be done to eliminate signs of dust marks and scratches.

If such a course is faithfully followed the photographer will be rewarded with a collection of prints which will be a great satisfaction to himself and a source of pleasure to his friends, and perhaps the means to an interesting income. They will provide a permanent testimonial to his patience, skill, and artistic accomplishments. Best of all, they will serve as a reminder of many interesting and happy hours.

Fig. 341 A Fighting Man of the Delta Division, Papua, New Guinea. photo by John W. Vandercook

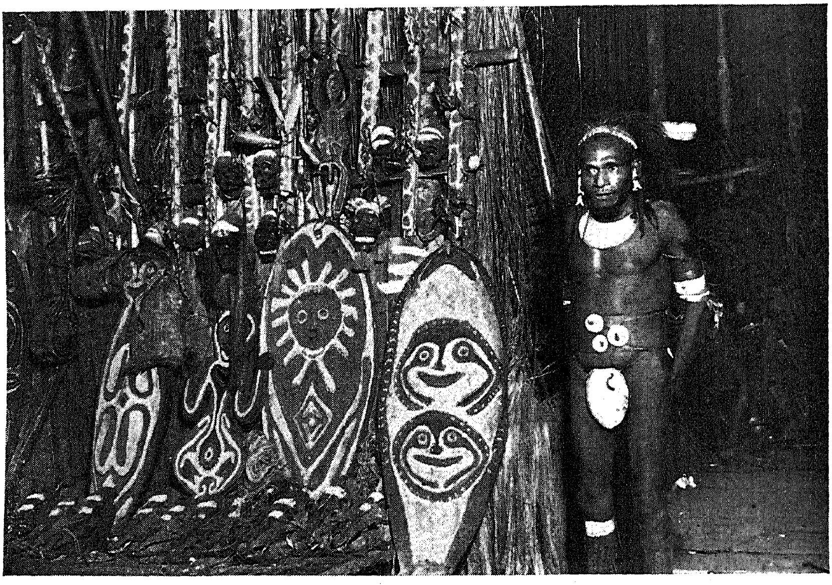


Fig. 342 Skull Collection and Native Carvings.—Interior of a Head Hunters House, Swamp Country of New Guinea. Flashlight photo by John W. Vandercook

LEICA PHOTOGRAPHY IN THE TROPICS
Notes on Special Film Handling

JOHN W. VANDERCOOK **CHAPTER 28**

Several years of photographic work under difficult tropical conditions . . . a 600-mile trek across the Central African Highlands in the middle of the rainy season . . . 400 miles by dugout canoe in the humid swamplands of southern New Guinea . . . and the highly variable conditions encountered in the uplands of Fiji and the Solomon Islands, have satisfied me of the singular advantages of the Leica camera, and the Leica method in general, for hot-country work.

One virtue which the Leica possesses is: It is the only camera I know of that when in use is sufficiently sealed to guard the film inside from moisture. Practically no humidity, I find, penetrates the closed camera. If the film has been cared for properly before and after use—satisfactory results are certain. Nothing can happen to it while it is *in* use.

My own methods of caring for film under tropical conditions—methods which have proven completely successful—are these.

I purchase all the film I need before leaving home. Even the less durable grades of super-speed pan will, I know from experience, last at least a year, if one takes care. And, so far as the tropics are concerned, I distrust the mails.

Some travelers order film to be sent out to them at various stages of their voyaging. The idea seems reasonable. Fresh film, straight from the factory, it should be fine. It is, unless it happens on the way to have had a long trip through tropical waters in the mail room of an average steamer. I have been in those mail rooms. They are usually amidships near the engines; near the equator their normal temperature is often well above 120°. And somewhere, in the midst of it, someone's film is simmering. For the same reason I allow no cases containing film to be taken to the baggage room. They stay with me in the cabin.

Film should be carried in a steel African uniform box. Boxes made in England for use in Africa and well worth the high price one pays for them—boxes guaranteed airtight and watertight. I have one which is large enough to hold, except for the cameras themselves,

all of a rather extensive photographic equipment. It is roughly the size of an ordinary suitcase. And one should improve it in one particular which the makers overlooked. African uniform boxes are painted black when one gets them. Mine is now painted with a white enamel. When, as it often is, the box is being carried in the sunlight on the top of an African's head or a South Sea Islander's shoulders, the difference in the interior temperatures between a black box and a white one is decidedly perceptible. And very important.

All films, besides being kept in an airtight case, should be additionally protected in the usual way, by being packed in tins sealed with a twice-around wrapping of adhesive tape. There is no need to take any further means of preserving them until after they are exposed.

Then, in hot climates and under conditions of high humidity, it is inevitable that negative films, even in a very brief space of time, will absorb a certain amount of moisture.

Single quarter-plate film packs which I have used have absorbed, by actual measurement, more than a teaspoonful of water. This absorbed moisture, however, can be and must be removed by a very simple means.

A Simple Dehydrating Method

After a film is exposed return it to its tin, but seal in with it several dried squares of calcium-chloride saturated blotting paper. This chemical has the admirable characteristic of drawing extraordinary quantities of moisture out of anything with which it comes in contact.

The calcium-chloride blotters are prepared quite simply. Purchase a few ounces of pure *Calcium Chloride,* obtainable at any chemical supply house, and dissolve it in a small cooking pot full of water. Into this solution place forty or fifty 2 by 3 inch, or any other size which is convenient, bits of ordinary white blotting paper of a good grade, and simmer slowly over the fire until all the water has been boiled out of the pot. The blotting paper oblongs will be found to be sticky and still wet. Being careful not to scorch them, dry these in an oven. The moisture in them, it will be found, is driven off very slowly and the operation takes a suprisingly long time —but it is worth it. Thick asbestos paper could also be used for this purpose.

When the blotters are comparatively crisp and dry, seal them quickly into an absolutely airtight container. They will then keep indefinitely.

When an exposed film is returned to its sealed tin, put two or three of these pieces of blotter in with it, and after several days, take them out and replace them with fresh dry pieces. The old ones will be found to be almost incredibly saturated, but they may be dried out and used again an indefinite number of times. Repeat this process until, after an interval, it is found that the blotters are no longer absorbing any moisture. If another dry bit is put in for good luck the exposed film will in all probability remain in perfect condition in any tropical climate for from six months to a year and when at last it is taken out for development it will be found to be bone dry.

Developing the Film

Development is of course extremely difficult in the tropics. There is usually inadequate water, and that is warm. But, if Calcium Chloride is used, there is no reason to hurry. It is, I have proven to my own satisfaction, far less hazardous to wait for good developing conditions than to attempt bad ones.

Large negatives, of course, can be developed at high temperatures with the assistance of special hardeners and the results, if one is more than usually skilful in technique, will be perfectly satisfactory.

But Leica films, I am convinced, *must* be developed at low temperatures and only at low temperatures. No matter how efficient the hardener used, irreparable damage will have been done to the

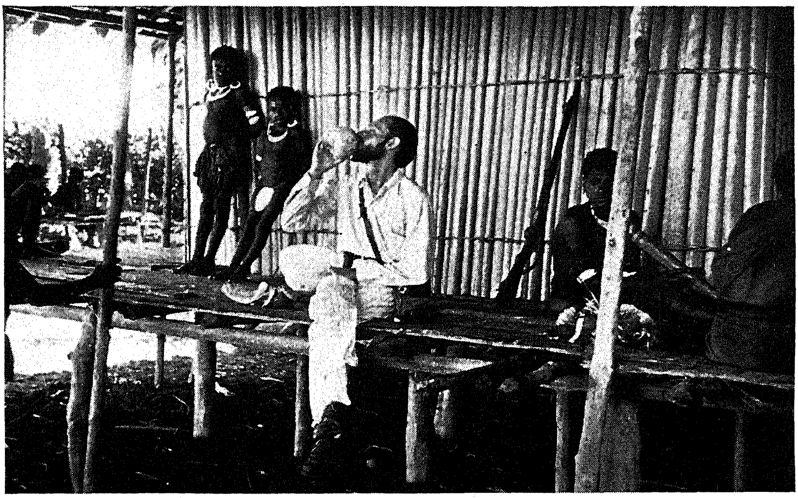


Fig. 343 John W. Vandercook Stops for Refreshments in New Guinea

grain of the film in the first minute or two of development in a warm solution. *Wait for ice.* Wait, if necessary, for months. It will be worth it.

When at last ice is obtainable, keep all solutions *below* 65°. If still in a warm climate, start the development at 60° or even lower, and leave a thermometer in the solution during the whole period of development. By the time the development is finished the temperature of the solution, do what one will, will have risen perilously. To time the development accurately, one must therefore strike an average. For example, if development has started with the solution at 60° and has then risen to 70°, time as if for a temperature of 65°. Rinsing water and hypo had best err on the side of coldness rather than warmness. The same rule holds for the washing water. Also it is as well to remember that the actual dissolving of a dry developer raises the water temperature. Allow accordingly. It goes without saying that if one is using ice, water is scarce. Leica film has no more useful characteristic than the small quantity of water it requires for thorough washing. If a Reelo tank is used, fill it up, let it stand for a minute or two, then swish the water out of it with a vigorous rotary motion. If this is repeated six times the film will be quite clean. Eight changes are just so much safer—*if the tank is constantly handled, rotated and shaken, then completely emptied before the next bath is poured in.* With practice (touch the film to your tongue), taste is an excellent indicator as to whether or not a film is free from hypo. (Water containing hypo has a characteristic sweetish taste.)

Six quarts of water are sufficient for the development, fixing and washing of one Leica reel—an economy of great importance in most tropical countries.

Dry the film thoroughly with ultra-soft chamois or a very old and oft-washed bit of soft cotton material, and dry away from dust.

Incidentally, patent hypo-removers, in my experience, are fatal to Leica negatives. They have a curious explosive effect upon the texture of the negative which, though it would not be noticeable in the case of large pictures, produces extremely coarse grain.

Another point. The wise traveller avoids carrying liquids. Take along a dry developer. With equal reason, avoid developers that are put up in fragile glass tubes. Those tubes, if travelling is hard, will break with amazing ease.

And, most important point of all, a black cloth changing bag such as is made for motion picture use is the essence of pleasant

Leica travelling. A changing bag frees one from the need of a dark room and all necessary Leica operations can be performed in one. I buy my negative film in 100-foot spools and cut and wind them in a changing bag. Film may be introduced into the Reelo tank in a changing bag—and if one is using film faster than one has an opportunity to develop it, exposed films may be transferred from their cylinders to an empty 100 foot spool for storage and for Calcium Chloride dehydration—in a changing bag.

One final point. Some Leica users have difficulty in getting film "started" in the Reelo tank—the one which I personally prefer for tropical and changing bag use. Try this. Before attempting to get the film into the Reelo spool, first unwind it completely from the film magazines. For one thing, the "far" end is already shaped to a point suitable for insertion in the Reelo spool; for another, the weight of the cylinder, pulling at the film, tends to cause buckling. One works more smoothly with no impediment other than the film itself.

EDITORS' NOTE: Elimination of atmospheric humidity (dehydration) from photographic materials and equipment presents quite a problem to photographic workers in the tropics. Primarily, but not exclusively for their benefit a new standard product known as "SILICA GEL" is recommended for this purpose. This is a manufactured material, hard and glassy, resembling in appearance the clear quartz granules. Silica Gel is highly porous and hygroscopic. Its pores are invisible but their capillarity is quite remarkable. The material will absorb up to 50% of its own weight of water from saturated air. Being chemically and photographically inert it is an ideal material for dehydration of photographic materials. It can be used over and over again: it is easily reactivated or regenerated by heating at a temperature of 300° F. (150° C.) for from three to four hours. This is easily accomplished by placing Silica Gel in an ordinary kitchen oven.

Silica Gel can be obtained from The Davison Chemical Corporation, Silica Gel Division, Rouse Building, Baltimore, Maryland.

Silica Gel should prove very popular among miniature camera workers for such odd tasks as dehumidification of films which stubbornly form Newton rings in the enlarger. A Leica worker in West Africa reports that he made an airtight camera case containing two trays filled with Silica Gel. This arrangement not only dries out the film while it is in the camera, but also prevents formation of mould in the camera mechanism and between the lens elements, something which frequently puts the camera out of commission in that part of the world.

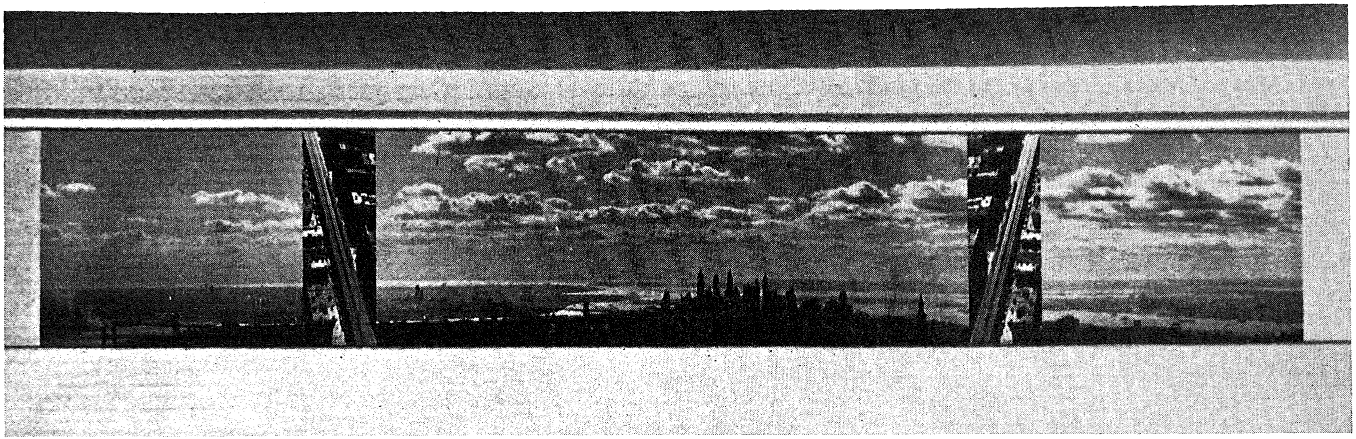


Fig. 344 Photomural...New York Skyline

John T. Moss, Jr.

PHOTOMURALS WITH THE LEICA

JOHN T. MOSS, Jr. CHAPTER 29

In Chicago in May, 1934, the world's largest photomurals were presented to the public in the Ford Exhibit at "A Century of Progress". These photomurals, which were photographic enlargements, formed a basic part of the wall itself and decorated a wall area twenty feet high by five hundred and eighty feet long. The individual pictures, of which there were thirty in number, were twenty feet high and ranged from eighteen to thirty feet in width. I had the interesting experience of being closely connected with the making and installation of this huge job of "pictorial wall papering". I have been asked many times to describe the procedure of making these enlargements, and knowing my interest in Leicas, quite often the broadside of questions concerning the photomurals would begin with, "Of course these enlargements were made from Leica negatives?" (Said with a gleam in the eye, which indicated a readiness to call me a liar if I answered in the affirmative.) The answer was obviously "no", but the idea of making photomurals from Leica negatives is by no means as absurd as it may sound. It can be done as accompanying illustrations show.

Relation of Photomurals to the Architecture

Photomurals are not just large photographs hung on the wall. The same principles apply to photomurals as do to painted murals. They should bear some relation to the wall space and surrounding architecture. There are, of course, many different types of rooms and if two extremes of the range of variation are selected, it may seem that the same principle could not possibly apply to both. After a close study of the two, however, it will be evident that the same foundation supports both types. Let us consider the treatment of a small room, two walls of which are paneled by moldings into three square panels each, each panel containing a four foot square photomural which is a complete scene within itself. Compare this to a long strip of wall space ten feet long and two feet high, above several doors on a flat wall. In the long narrow photomural a continuous scene may be used which is selected because it has certain accents in the pic-

torial composition which occur over the doors. Thus the picture itself relates directly to the architectural structure of the wall. In the paneled room, the type of decoration divides the wall into definitely formed spaces and the picture in each space can therefore be complete within itself. There is still no reason, however, why these three separate pictures cannot bear a relation to one another in mass, subject matter and general composition.

A good general rule to follow in making a picture for a wall decoration is to select the wall space to be decorated first, and then decide on the photograph to fit the space. Too many people would be inclined to make an enlargement of some arbitrary dimension and then stand in the middle of a room and wonder on which wall it would look best. This is hanging a picture, not making a mural to fit a wall space. Areas of wall at the sides of windows or between doors are often hard to decorate in the customary manner, and yet they often lend themselves very well to the use of photomurals. If such a space is chosen, care should be used to relate the area covered by the enlargement directly to the wall as a whole. Establish the limits or breaks in the wall itself and make the top or bottom of the picture line up with the top of a door or a molding, limiting its width by some other definite line on the wall. If this is not done the mural will not relate to the area of the wall, but will just be another picture "hung" at random on the wall. Elements or lines of the photograph itself can also be made to run parallel with, or line up with limiting masses or lines of the wall. When the mural is being planned these lines should be given careful consideration.

In most cases it will be found that only a part of the negative will be used. When the enlargement is made, study the projected image in proportions of the chosen wall area. Mark off the unwanted parts and see which part of the picture fits best into the space. **It is often wise, at first, to make small prints about five inches by seven inches and crop them to the proportions of the wall area which has been laid out at one-quarter full size (1 ft. to 3 in.).** After the composition has been studied and arranged to the best advantage, mount these small prints upon heavy cardboard cut to the proportions of the wall space to be filled. This will allow you to see how all of the pictures will relate to each other when they are mounted in final size on the wall.

With a little careful study a picture can usually be found that will tie in pretty well with the wall space selected or with the room itself, if more than one wall is to be used. The relation of the picture

to the decoration of the room can even be carried as far as the furniture, if desired. If a high bookcase or cabinet is to be used in the center of the wall, the composition of the picture should relate to the point where the high mass of the piece of furniture breaks up into the picture. This is basically the same relation as mentioned before in the case of doors, and can be treated very effectively. If an unbroken wall space is to be used the photographs themselves can divide the room into panels and at the same time unify it as a whole. An example of this, on a large scale, is the photomural in the N. B. C. Studios in Radio City, New York. Here the photomural runs continuously around a circular room, but is divided into sections by the subject matter and tone of the prints of the photographs. A dark print is used next to a lighter one, but care had been taken not to get so much contrast that the wall as a whole would not tie together. The mural thus portrays the separate elements of broadcasting, but at the same time provides the room with a unified wall decoration.

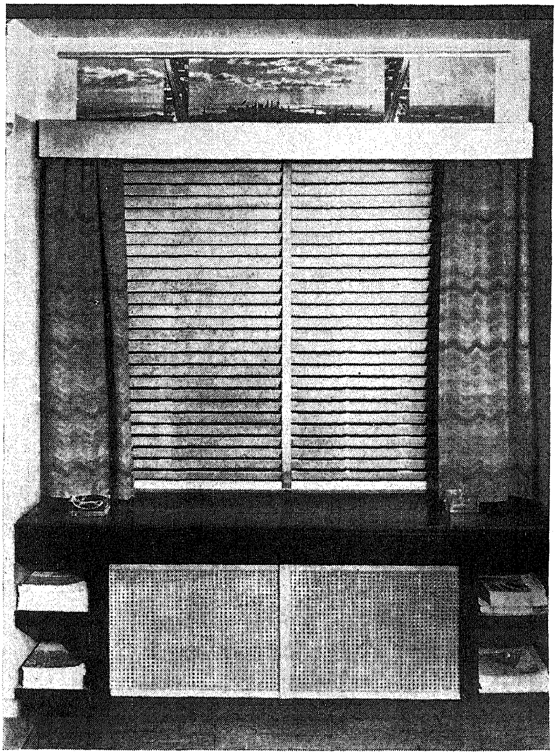


Fig. 345 Photomural by John T. Moss, Jr. Showing its Relation to Window and Wall.

Physical Limitations of Size

The Leica user cannot expect to produce photomurals twenty feet high by twenty-five feet wide. The manufacturing processes involved in the making of murals this size or even one half this size are beyond the physical capacity of most camera users. But what Leica user wants a photomural that size? It would be like having the Graf Zeppelin tied up in one's backyard. The Leica is a miniature camera, so scale down your photomurals accordingly. Even if you only make a mural three feet by four feet you will be making a greater enlargement in proportion to the Leica negative than the twenty-foot by twenty-five-foot enlargements, which were made from 8 x 10 negatives, resulting in a magnification of about twenty-four diameters. This scaling down does not mean using an 8 x 10 foot print stuck on the wall as a photomural. Two feet by three feet is a good size to begin with.

The large professionally made photomurals in most cases cannot be printed on one sheet of paper. The largest paper comes in rolls forty inches wide and several hundred feet long. This means that there must be one joint in the paper about every three feet. Very few photographers have the equipment to develop paper as large as three feet by ten feet thus making it necessary to use a horizontal as well as a vertical joint in most photographic murals. This does not harm the mural, however, if the matching of the tone values is carefully done. The average Leica user is probably limited to an eleven by fourteen inch sheet of paper, but this does not prevent him from making a mural to fit a larger space. If you are fortunate enough to have a tank that will take a piece of paper two by three feet or larger, by all means use it. It will eliminate much of the time required by matching. On the other hand, don't let your eleven by fourteen inch trays keep you from making a 4 x 5 foot mural, if you want one.

Subject Matter

Subject matter in photomurals is quite important. Just a large picture of little Junior sitting on the steps of the front porch will probably not make a good photomural. Junior has his place, and a very important place in most cases, but he doesn't do so well enlarged to half life size looking at you from the wall of the den with his best grin. The picture selected should be good from the standpoint of composition and not just the snapshot variety. That picture of Aunt Sophie on the steps of the Capitol at Washington probably is a swell likeness of Aunt Sophie, and anyone could be sure that the location

is Washington but, enlarge it to two by three feet and put it on the wall and the answer is: "So what?"

Pictorial subjects for murals should have beauty or action or both. If the action is good, it will show a grace of line and mass which will be appropriate to the composition in most cases. Landscapes or general out-of-door scenes quite often lend themselves very well, if the object is just to fill a wall space with a pleasing picture without any particular purpose of telling a story. If, on the other hand, the subject matter of the mural is to directly relate to the type of room in which it is used, then indoor as well as outdoor shots are suitable.

It is taken for granted that most Leica users would make photomurals for their own homes, or at least for rooms in which the character of the picture would be governed by personal interests of the Leica owners or their friends. If by chance you have the opportunity to decorate the walls of an office, a store, or a club by all means go to it. **Industrial subjects are excellent for photomural work** and he who can get a commission to portray the workings of a factory for the office wall of the president, for instance, has a job which is one of the most interesting.

Game rooms are among the best rooms in the home to decorate with Leica murals. On the walls can be shown shots of people using the ping pong table which is located in the room itself. Close-ups of trick pool or billiard shots could be arranged into a very decorative design along the wall.

The den, or library, is also an ideal place for photomurals. Golf, tennis, fishing, hunting or any of the outdoor hobbies of the Leica owner can be represented. The trips or tournaments of the summer months can be with you all the year round, and make an appropriate decoration for the walls.

Hallways and entrance vestibules are good places to decorate. Because they are only connecting links or entrances to other rooms, they can be treated in a more abstract manner as to subject matter. Here is a good place for your favorite landscape, whether it be a shot of Morro Castle in Havana, or a lucky exposure of the snow capped peaks of the Rockies at sunset. If the hall is a long and narrow passage a series of shots could be worked together to show in resumé fashion an automobile trip through Canada, or the West. Pick out the best shots and arrange them so they are in sequence, and bear a relation to each other in composition along the wall.

One thought for a bar or drinking room is a series of Leica close-

ups showing the mixing and ingredients of the popular drinks of the present day. If such shots are carefully illuminated during the photographing, the prints will work into a very decorative pattern of highlights and shadows. Your guests will know exactly what they are getting when they order their favorite drink.

Another thought for the background of the bar itself is a shot of liquor bottles well arranged. With some of the good displays in the present day liquor store windows at ones disposal, a shot like this ought not to be hard to find.

If you are adept at facial expressions and wish to decorate the wall with a flavor of humor, get a long cable release and shoot yourself registering various states of emotional anticipation as you are about to indulge in your favorite mixture.

Children's playrooms or nurseries are good fields to experiment with. Here the murals may be treated in an educational manner or as a record of the junior members of the family. Here is the appropriate place for the children, but show them in action, if a record of children is the type of mural desired. Children on the beach or in camp offer many chances for good composition regardless of whether it is your own child or not. It is a good idea when arranging the pictures to forget that the children bear any relation to you, but keep only the composition of the space in mind. By doing so you will not be tempted to detract from the decorative quality of the wall by putting in a picture of your daughter, which may not fit in the scheme, simply because she wears your favorite expression in that shot.

From the educational angle, pictures of the zoo might be arranged around the wall of a child's playroom and serve the same purpose as juvenile picture books. Modern toys lend themselves very well to photography. With a little imagination, a very decorative and amusing band of shots might be made using the child's own dolls and toys.

Garden or floral shots can be very effectively used in decorating dining rooms walls. These might be used in the form of a continuous band, or if the dining room is divided into panels, such as are often found in Colonial houses, these panels can be filled with photomurals. In using floral shots, a more effective picture can be obtained by making close-up shots rather than general broad views of an entire garden. The close-up shows the beauty of the flower itself and is more interesting to the observer. When garden shots are taken for photomural purposes, get a group of flowers in the foreground of the picture to further enhance the beauty of the entire garden in the

distance. As in any type of picture, this gives the photograph depth and prevents the picture from appearing flat and unreal. Beautiful landscapes are appropriate for the dining room. A panorama type of shot used as a continuous band or split up into panels would be very effective.

Composing the Photomural

Remember that in all previously mentioned examples the entire wall space does not have to be covered with photographs. In most cases it is much better not to cover too much of the wall. By only using a single space at one end or side of the room, the photograph takes on much more importance and you do not get the effect of the room just being papered with pictures. Photomurals are not just wallpaper in the all-over sense of the word. Wallpaper designs have been made from photographs, but a mural requires an entirely different treatment. The larger the area one attempts to cover with the enlargement the more difficult the composition of the wall becomes, so it is well to start out on a small scale until one makes a few successful experiments.

In figure 344 the space above the window is approximately six feet by one foot, and the subject matter was chosen both for its horizontal feeling and because of its local interest. Here the panel has been divided by a vertical picture strip on each side in order to separate the two scenes at each end. These two end scenes are located in the mural as they actually are in the New York skyline, but as they were taken about one-half minute apart, the clouds did not match with the clouds in the central panel. The shot of the elevated railroad tracks was therefore used in a purely abstract manner to separate the three views. The same shot was used on both sides, the negative being reversed on the right side in order to have the two diagonals of the pictures extending toward the center of the window. The horizontal feeling of the Venetian blinds of the window, broken by the two vertical tapes are thus repeated in the photograph by the horizontal clouds and skyline broken by the two vertical strips.

Because of the shape of the space horizontal joints in the paper were not necessary. There are two vertical joints in the center picture, but by careful matching these do not show at all. There is a joint on each side of the two vertical panels, but because these are frankly used as separating inserts in the composition, the joints are not a problem of matching. The Leica mural thus ties in well with the end of the room and makes a very interesting panel above the window, as well as presenting a view of the New York harbor which cannot be seen from many places in the City.

The above is just a simple example of what can be done in the living room. Innumerable variations of composition and subject matter are waiting for Leica users to make the most of. **There are few rooms in the house which could not be made more attractive by the use of Leica murals.** The bedroom, the bathroom, and even the kitchen, if the cook will allow it, all have their possibilities. A frieze of shots of truck gardens or cleverly arranged vegetables might make the kitchen a bit more unusual and decorative. As to the bathroom, if it has a tile wainscot six feet high, a narrow band of goldfish shots might be used just above it. Another possibility presents itself in a collection of shots of the surf taken while on a vacation at the shore.

In the case of the kitchen and bathroom shots, the photographic paper may be sprayed with a thin coat of colored or transparent lacquer in order to tone it in with the general color of the walls. Care should be taken in doing this, as too much color will obliterate the details of the photograph. But a thin coating will add rather than detract from the general effect. A cheap spray gun may be purchased for this purpose. Care should be taken to mask off the wall area directly adjoining the mural when spraying the lacquer.

Grain and Viewing Distance

One of the most important things in the making of satisfactory Leica murals is fine grain of your negatives. If your negatives contain as little obvious grain as possible the enlargements will be of the best. It might be the case, however, that a negative selected from your file which seems to fit perfectly in a certain wall space shows quite a bit of grain when enlarged to the required size. If the wall area is in a darkened hall or up high for instance, this grain will not be noticed, particularly if the viewing distance is great enough. A mural such as shown in figure 344 could contain more grain than one which was to be viewed close at hand. This mural is about nine feet above the floor and in order to see it at the proper angle a person has to stand about six or eight feet away from it. At such a distance an average enlargement of grain would not detract from the mural. This does not mean that grain should be disregarded, and paraphenylene diamine or some similar fine-grain development is recommended as it will give the best results when enlarged. It simply illustrates that you can use a negative with grain in certain instances. If negatives are made purposely for the mural, decide what effect you wish on the wall and keep that in mind during the taking of the picture, the development of the negative, and the printing of the enlargement.

The actual making of Leica murals requires no more skill than it takes to make any eleven by fourteen inch enlargements, but it does require more patience.

If the design on the wall is to have the effect of a pattern of blacks and whites, get contrast in the negative and make prints which bring out this quality. If the wall is to have a general tone carried out by the mural, make the negatives less contrasty and print all of the pictures with the same general tone of gray. Negatives which are made especially for photomurals should be developed for a slightly shorter time than the average negative. It will be found that negatives which might be considered thin for a 5 x 7 inch print will produce a very satisfactory 20x30 inch enlargement. This is particularly true if a paraphenylene diamine developer is used.

Technical Photomural Procedure

There are two ways of projecting when an enlargement of more than the average size is desired. The Valoy enlarger can be turned horizontally, and the image projected upon a wall or it can be used vertically in more or less the usual manner.

If the horizontal method is used, the swivel extension arm is a very handy accessory. This allows the lamp housing to be swung at right angles to its normal vertical position, and fastened with a set screw. If, however, one does not own a swivel arm, the enlarging

stand may be used horizontally, but some method must be devised to support the free end of the tubular upright. Books or a box of the right height can be used, or a cradle of wood can be made with little effort. Thus the baseboard of the enlarger serves as one support and the books or box the other, the whole set-up taking the shape of an inverted letter "U". The enlarger housing must be moved around on its supporting arm until it is directly above the tubular support. In this position it can be moved forward and backward until the projected image on the wall or vertical screen is the desired size. Care must be taken to hold the enlarger housing with one hand when the other hand is used to move it along the tubular support, or it will swing down on one side or the other, upsetting the whole enlarger easel and possibly damaging the enlarger itself. Be sure that the tubular support is perfectly level, namely that the improvised support is the same height as the depth of the easel board which is fastened to the other end of the tube. If the tube is not level the projected image will be distorted. After the enlarger is set up in this position, some sort of surface should be selected to receive the projected image, such as compo-board or sheet cork, to which the photographic paper can be fastened with thumbtacks. A large drawing board may also be used. This board or projection surface is also useful in focusing, as a sheet of white paper can be tacked to the surface and the enlarger focused sharply. The white paper should then be removed and replaced with the photographic paper when the print is made. This horizontal method is perfectly satisfactory and will give enlargements of great size, but because the enlarger is in an unusual position some Leica users might find it awkward to manage.

The second method is one in which the enlarger remains in a vertical position. It can be placed upon a table of normal height (thirty inches), and raised to full height of the standard upright and it will enlarge the Leica negative to approximately two by three feet when turned around 180° from its normal position above the easel and projected upon the floor. The easel board should be weighted or clamped to the table to keep the enlarger from tipping over. This is the method that was used to enlarge the sections of the mural in figure 344.

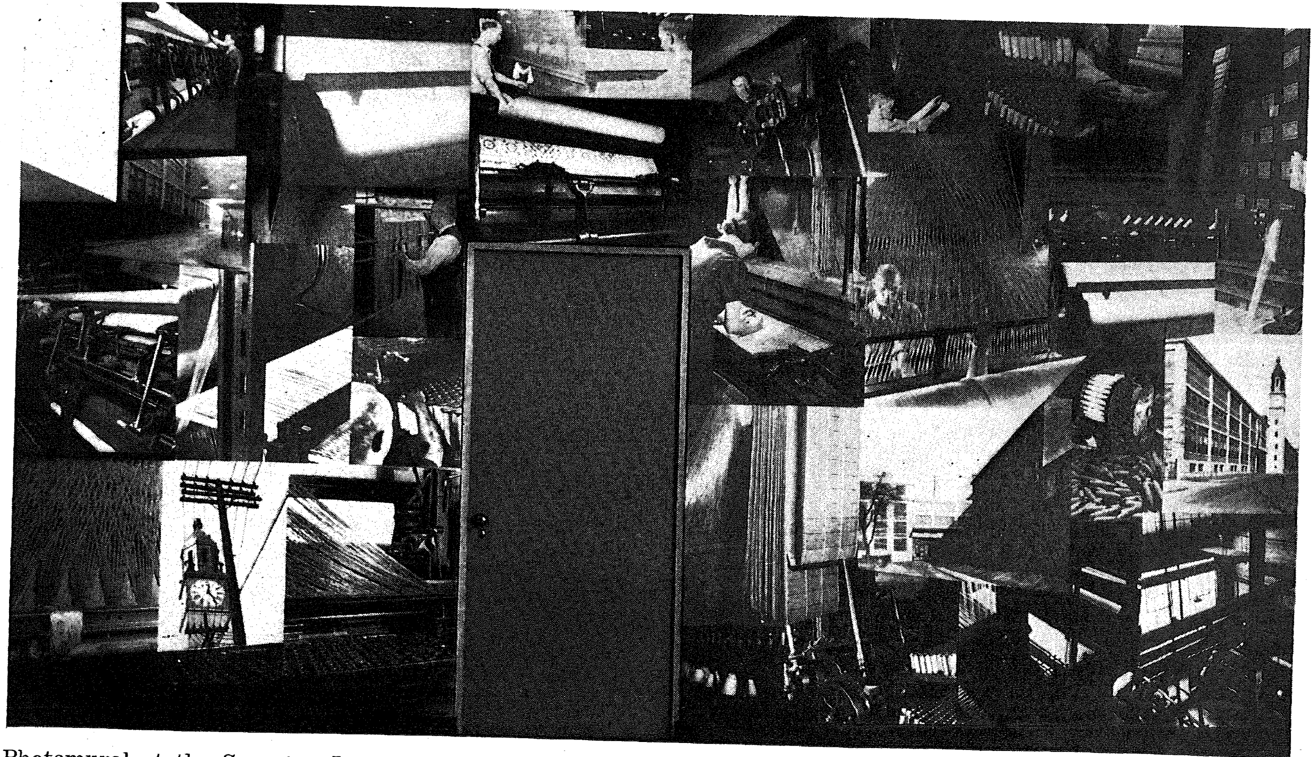
A piece of white paper was placed on the floor for the purpose of focusing, and also to determine where the various dividing lines of the sections of paper would occur on the image. The white paper had been marked off in rectangles the exact size of the various sections of the mural; and where the lines of these rectangles divided the

projected image were to be the divisions at which the sheets of printing paper had to be joined. The enlarger remained in one position so this method of plotting the position of each section of the mural in relation to the whole image was quite important in making sure the image matched perfectly at the edges of the sections. Only the skyline part of the negative was used as there was more sky than necessary in the frame of the picture, for this composition.

After test strips had been made to determine the tone value desired, the projection was then made on three eleven by fourteen inch sheets for the center picture starting at the left side. The image was overlapped about three-quarters of an inch on each piece of paper, so there would be a safety margin when the sections were mounted. Thus by having a slight bit of the same part of the image along each of the edges of two sections which are to be joined, it is easier to match the parts of the picture and there is no danger of leaving out a section of the picture in attempting to project just what is to finally appear on each section. The foreground was masked in each of the exposures in order to darken the sky and give the whole picture a general dark tone. The exposure was one and three-quarter minutes on the whole picture and then the sky was exposed for another one and one-quarter minutes, masking the foreground. A shorter exposure could have been made by using a photoflood bulb in the enlarger. The negatives of the end panels were then exposed in the same manner, the test strips having shown that the exposure was the same as the center panel. The two inserts were then exposed for a period of time that would give them a slightly darker tone than the center and end panels. This value was determined by a test strip and used to further emphasize the vertical breaks in the composition. The prints were made on Eastman Vitava Projection Paper (C2), but single weight paper is preferable as it will not curl at the edges as easily and pull away from the wall after it is mounted.

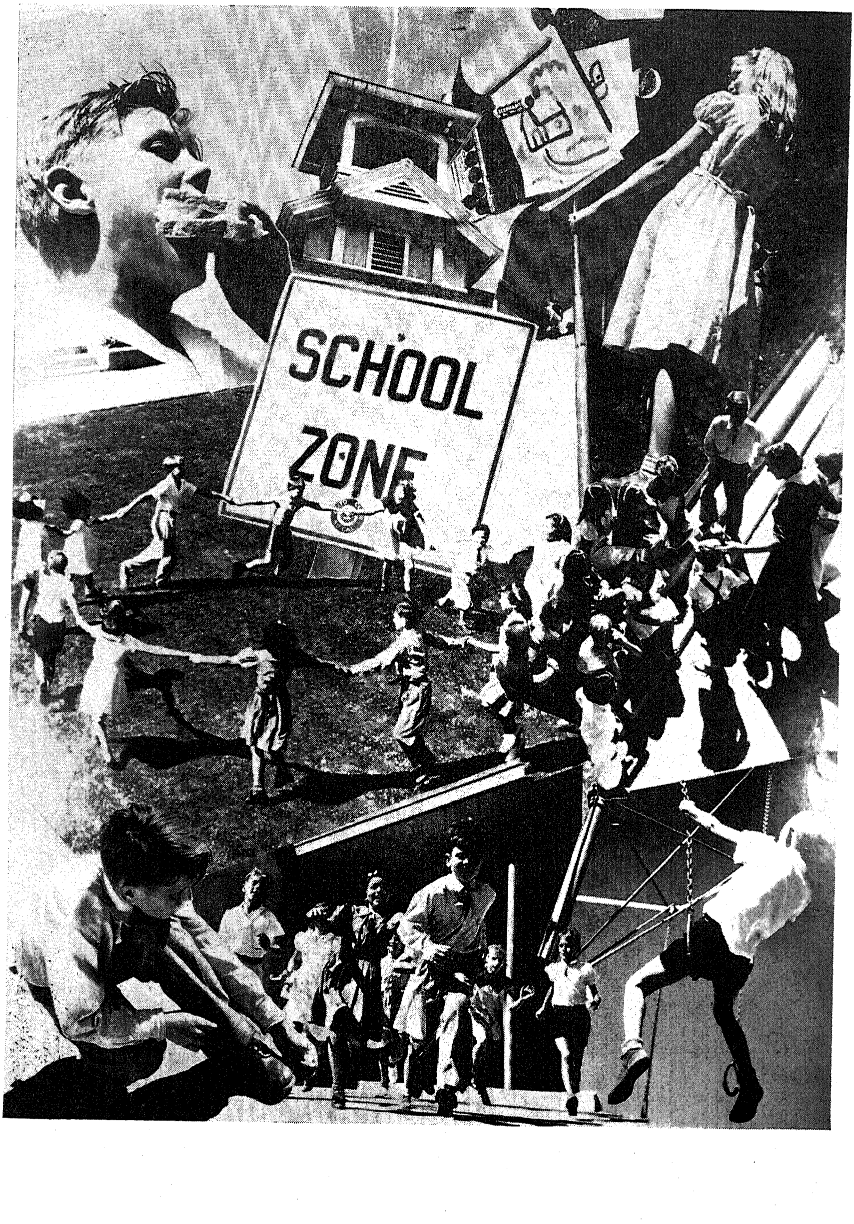
The timing of the exposure and of the development is important, as even small variations will give a different tone of gray and thus show a line where the two pieces of paper are joined together.

Care should be taken in the focusing of the image. This can be done at f:3 5 and then the lens should be stopped down to between f:4.5 and f:6.3 as the spread of light is more uniform at this opening. Certain negatives may be found difficult to focus sharply when they are enlarged to 30 or 40 diameters. One method of setting the focus is to remove the negative from the enlarger and place a small feather between the condenser and the frame which carries the negative. The lens should then be focused sharply on the finest part of the feather. The fine lines of the feather will be finer than any line on the negative, enlarged to this size, so if the feather outline is



Photomural at the Scranton Lace Company office, Textile Building, New York...by Barbara Morgan, Willard D. Morgan...John Weber, Architect

This photomural, measuring 10 by 20 feet, covers one wall and is composed of forty individual pictures, representing various steps in the manufacturing of lace curtains



Photomural

Victor Haveman

sharp one can be sure that the negative will be, with that adjustment. Remove the feather and leave the enlarger set at that focus during the projection of the negatives.

After the sections of paper were carefully developed and fixed they were allowed to dry in the usual manner. The edges of the dry prints were then skived or pared; that is, they were turned face down and the edges were thinned by tearing off a thickness of the paper about one-half inch along the edge. This bevels the edges of the paper and prevents the edges from peeling off along the joints after they are pasted to the wall. It also prevents a double thickness of paper at the joint, which would show. If the paper is beveled down as thin as possible without tearing the edge, the overlapping edges of the two sections will amount to the same thickness as a single sheet of paper. The edges can also be beveled by rubbing the back with sandpaper until the edge of the paper is almost as thin as tissue paper. Thin muslin was then applied to the wall (or mount) with vegetable glue thinned to a brushing consistency. The sections of photographic paper were then wetted and glued to the muslin surface (after it was thoroughly dried). The matched joints should overlap about one-half to three-quarters of an inch. If the edges have been thinned as described above there will be no double thickness of paper at these points. The various sections of paper should be carefully applied so that horizon lines or other parts of the image match perfectly.

If you do not wish to apply the mural directly to the wall, it may be applied to masonite, or wall board. One-eighth inch thick masonite will carry quite a large mural without any extra bracing on the back of the panel itself. If the murals are mounted in this manner they may be changed from time to time without damaging the wall surface. The prints should be spotted very carefully as defects will show up on a mural and detract from the decorative effect of the wall. This spotting can be done with a brush and India ink, or on large enlargements a paper stump and charcoal pencil will often be effective. The charcoal pencil will work particularly well where even tones are desired to cover a large defect in the print. The pencil should be rubbed over the spot lightly leaving a series of lines. These lines should then be blended into an even tone by rubbing them with the paper stump, or a piece of cotton.

The above mentioned examples are undoubtedly not all of the uses for Leica murals but they should serve as a start toward another service for this many-purpose camera. Whatever the location of the Leica mural, relate it directly to the wall, don't "hang it".

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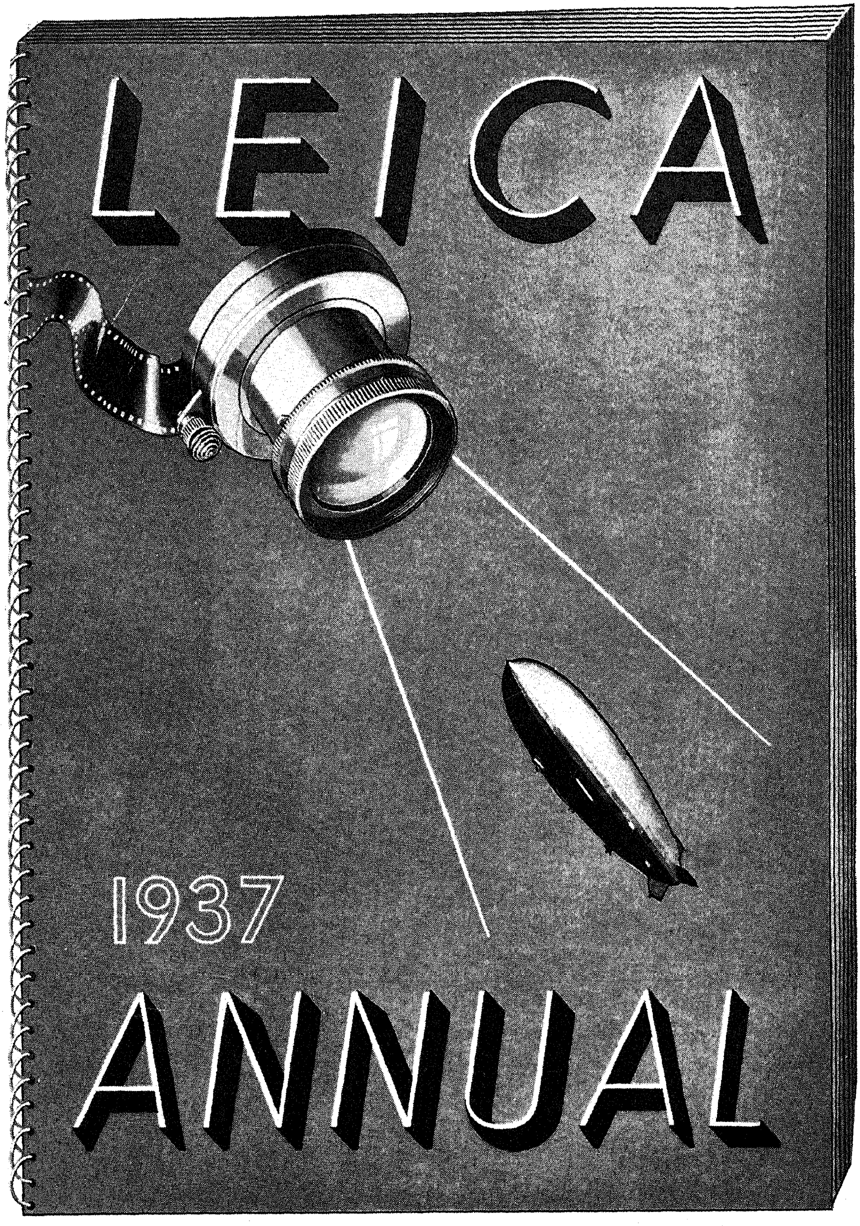

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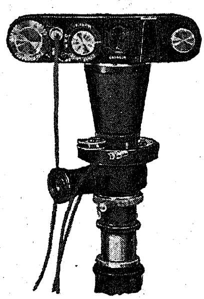

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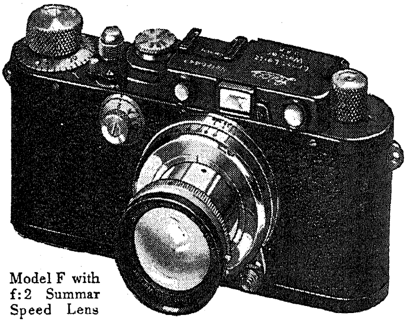

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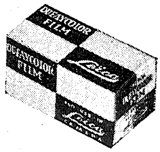

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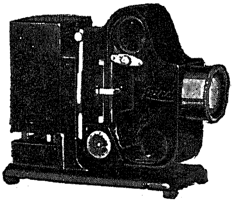

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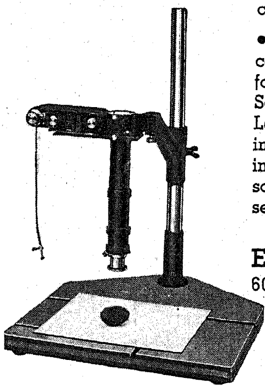

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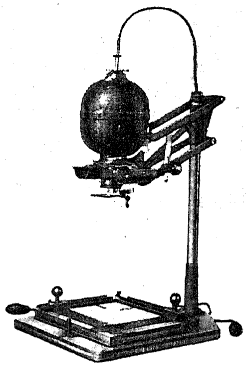

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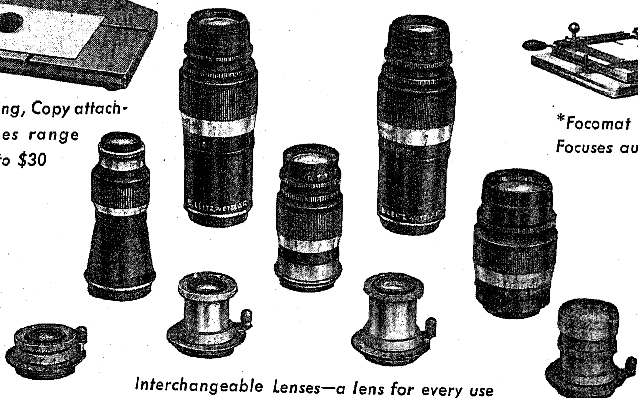

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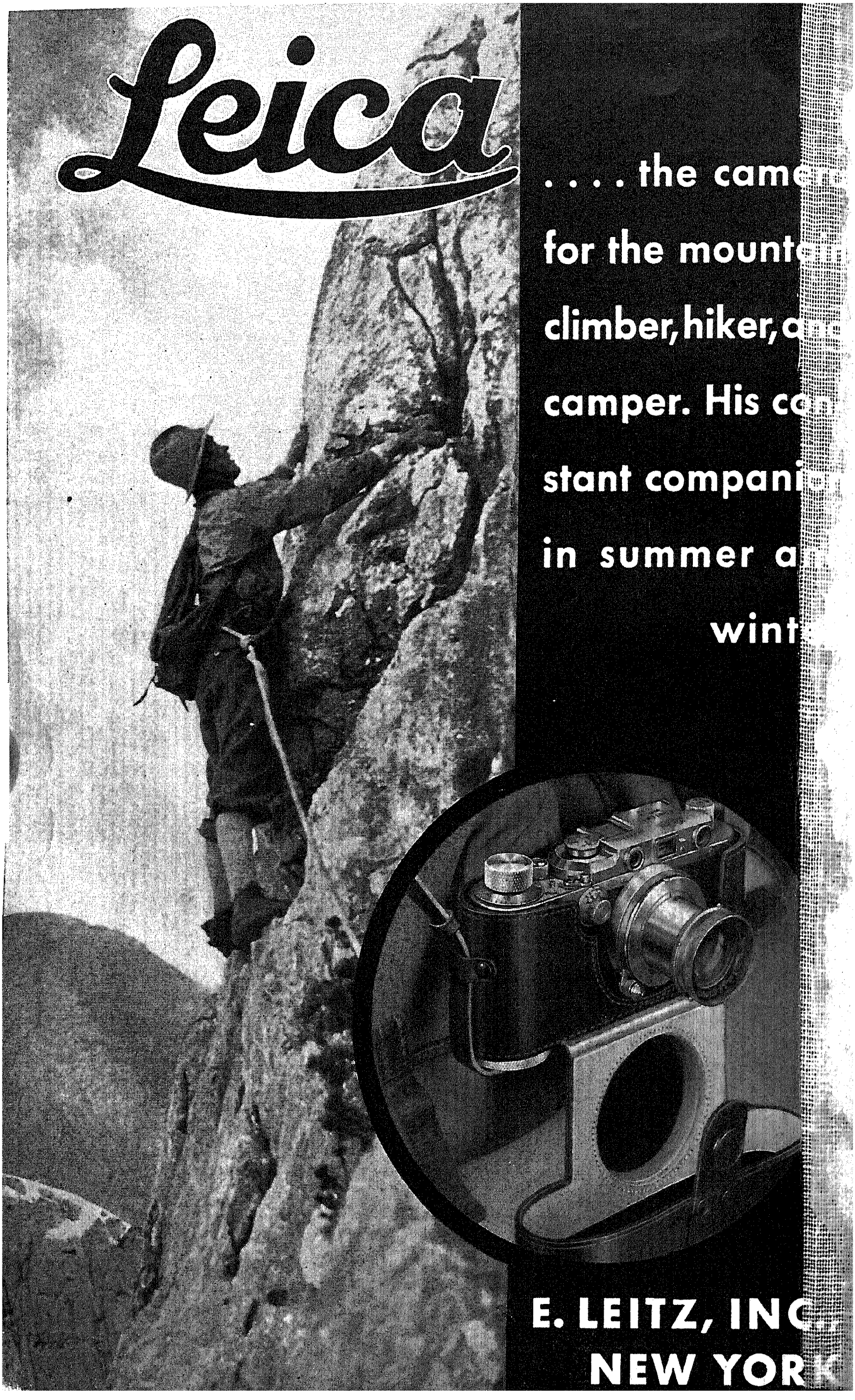
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